Hardware & Functionality

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1 System documentation

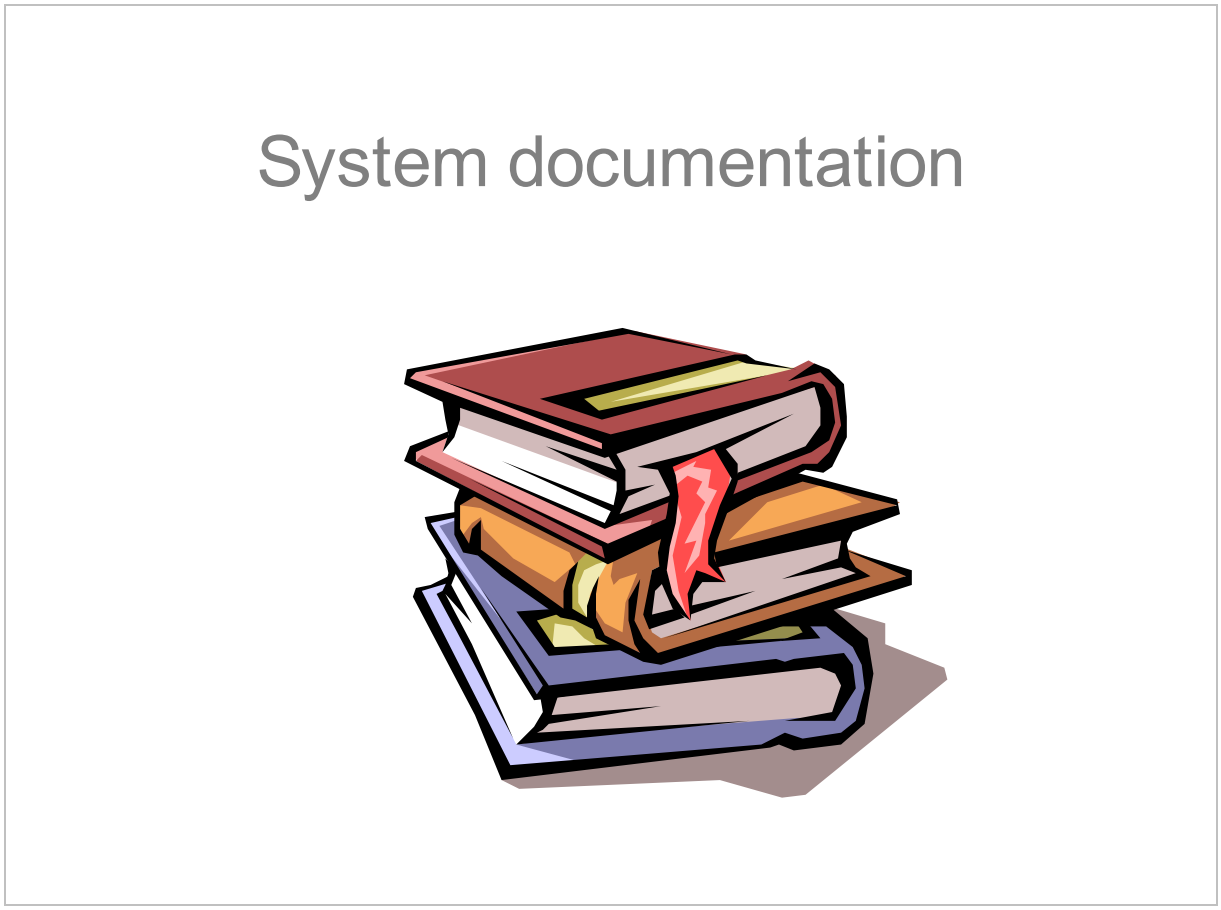

Fig. 1 System documentation

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1.1 Documentation overview

The documentation of the SURPASS 7300 comprises the following descriptions and manuals:

TIP
The documentation is available on CD-ROM.

Environmental Product Declaration (EPD)

The purpose of this document is to provide environmentally relevant information of a specific Nokia Siemens Networks product.

This document shall not be interpreted as a specification, modification or amendment to the specification, or additional or other warranty of any kind. In case of discrepancy between this document and the Product specification or terms and conditions of the valid supply agreement between Nokia Siemens Networks and the customer, the supply agreement and Product specification shall always prevail over this document.

Product Description (PD):

The Product Description (PD) provides an overview of the entire system. PD includes description of features, components application, performance features, NE types, operating theory, block diagrams, plug-in card descriptions, and detailed technical specifications.

Installation and Test Manual (ITMN):

The Installation and Test Manual ITM contains instructions on how to install the SURPASS hiT7300 system components. This includes mounting the sub-racks in the equipment racks, connecting and testing power cables, electrical cabling and plug-in card installation. The ITM also includes the post-installation Commissioning procedures.

Optical Link Commissioning (OLC):

This document gives the instructions for performing post-installation turn-up and link optimization procedures and describes the standard optical link commissioning procedure for SURPASS hiT7300 system.

OLR and ONN Commissioning (ONN / OLR COMM):

This document contains instructions for commissioning of OLR and ONN network elements and described commissioning process of taking installed OLR or/and ONN and bringing them to an operational state.

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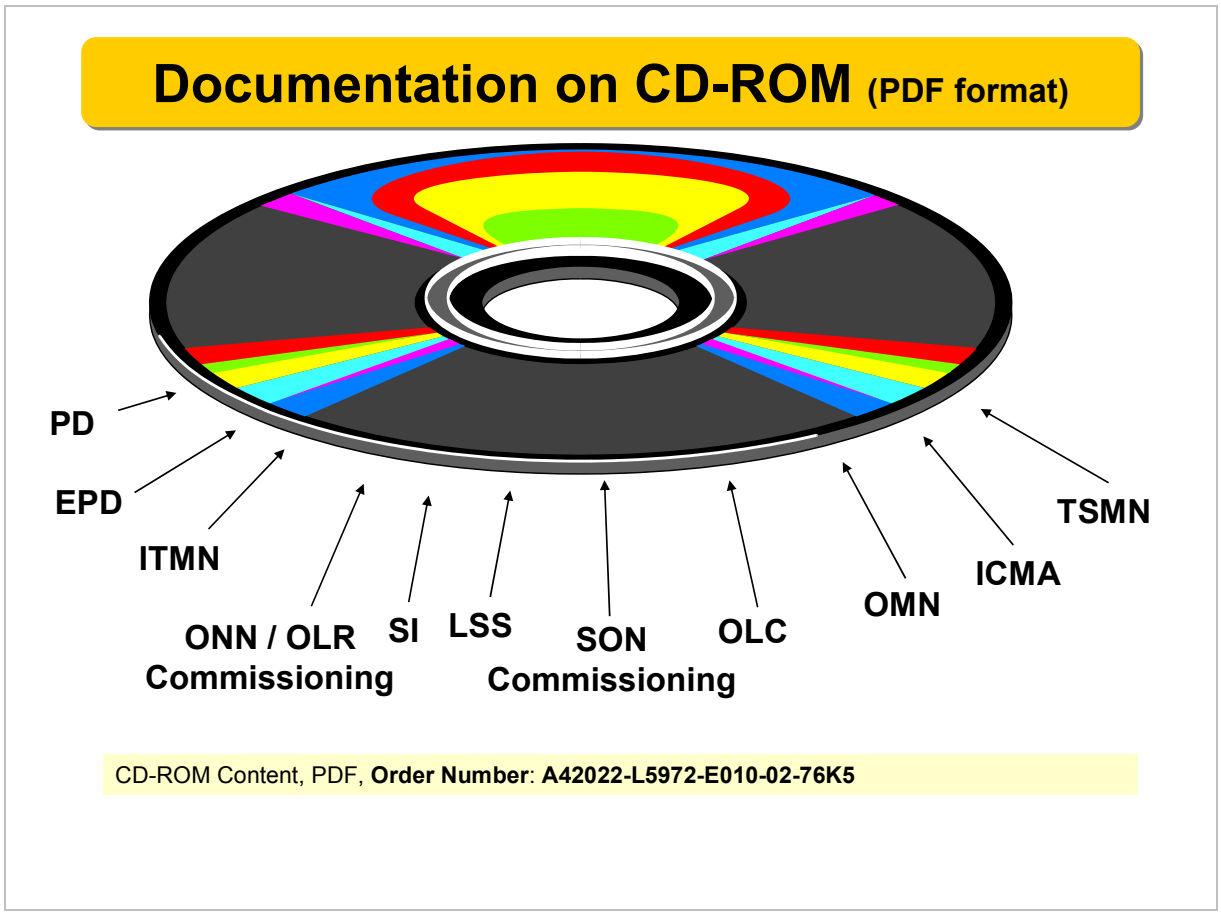

Fig. 2 User Manuals on CD-ROM

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SON Commissioning (SON-COMM):

This document contains instructions for commissioning of SON network element and described commissioning process of taking an installed SON and bringing it to an operational state.

Open Source Licenses (OSL):

List of used open source software licenses.

Operating Manual (OMN):

The Operating Manual (OMN) provide information on how to operate, monitor and maintain the SURPASS hiT7300 system via Element Manager (EM) of the Local Craft Terminal (LCT), principles of alarming and HW upgrade procedures. The Element Manager (EM) is an easy-to-use Graphical User Interface (GUI) with extensive Online Help.

Trouble Shooting Manual (TSMN):

The Trouble Shooting Manual TSMN deals solely with alarm handling and trouble shooting. In the TSMN is obtainable detailed information to troubleshoot and remedy alarm events. This document describes troubleshooting procedures to be performed in reaction to alarm events generated in the SURPASS hiT7300 system.

Interconnect, Configuration, and Mechanical Assembly (ICMA):

This document deals with the electrical and optical cabling of the sub-racks and racks; it illustrates the rack equipment of the several variants and contains block diagrams and cabling lists, additionally it describes the installation and cabling for the SURPASS hiT7300 system. ICMA contains complete set of drawings that depict rack, sub-rack, and plug-in card arrangements, as well as electrical and fiber cabling plans.

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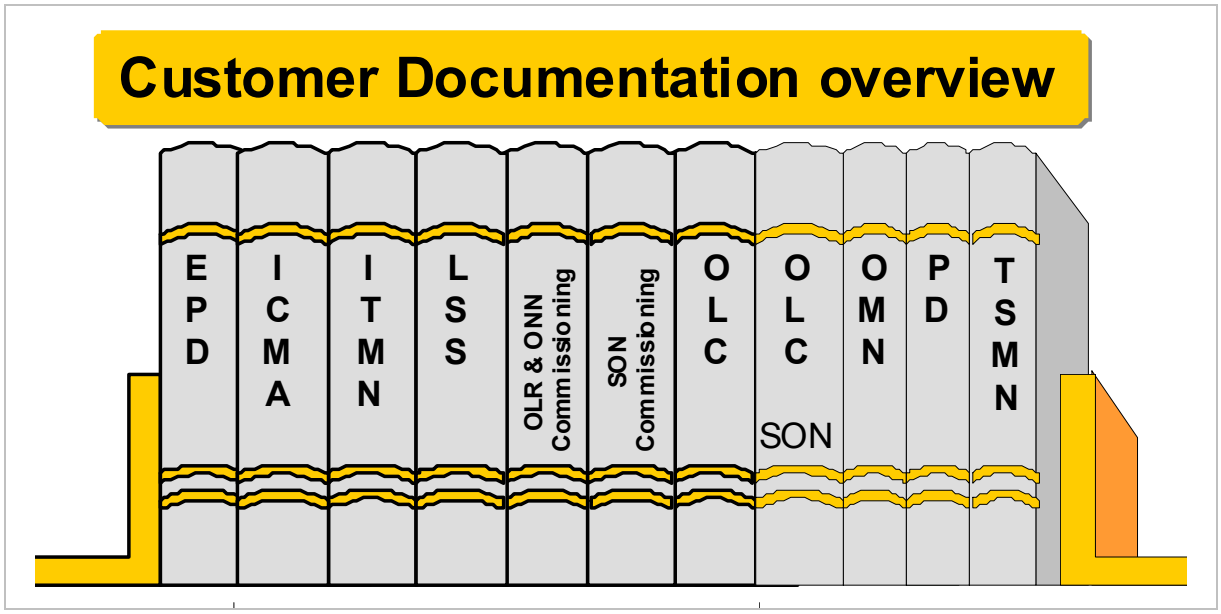

Fig. 3 Customer Documentation

EPD	Environmental Product Declaration
ICMA	Interconnect, Configuration and Mechanical Assembly
ITMN	Installation and Test Manual
LSS	Long Single Span Architecture User Manual
NE_COMM	OLR and ONN Commissioning
NE_COMM_SON	SON Commissioning
OLC	Optical Link Commissioning
OLC_SON	Optical Link Commissioning SON
OMN	Operating Manual
PD	Product Description
TSMN	Troubleshooting Manual

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1.2 Online help system

There is possible to use the online help system that is provided with the NE software to receive information about all the window contents and menus. The Contents, Index and Find buttons enable the online help to be searched quickly and conveniently. You may also display essential steps of important operating sequences via the help table of contents. Individual help topics can be printed, and context-sensitive help texts called up directly from the user interface.

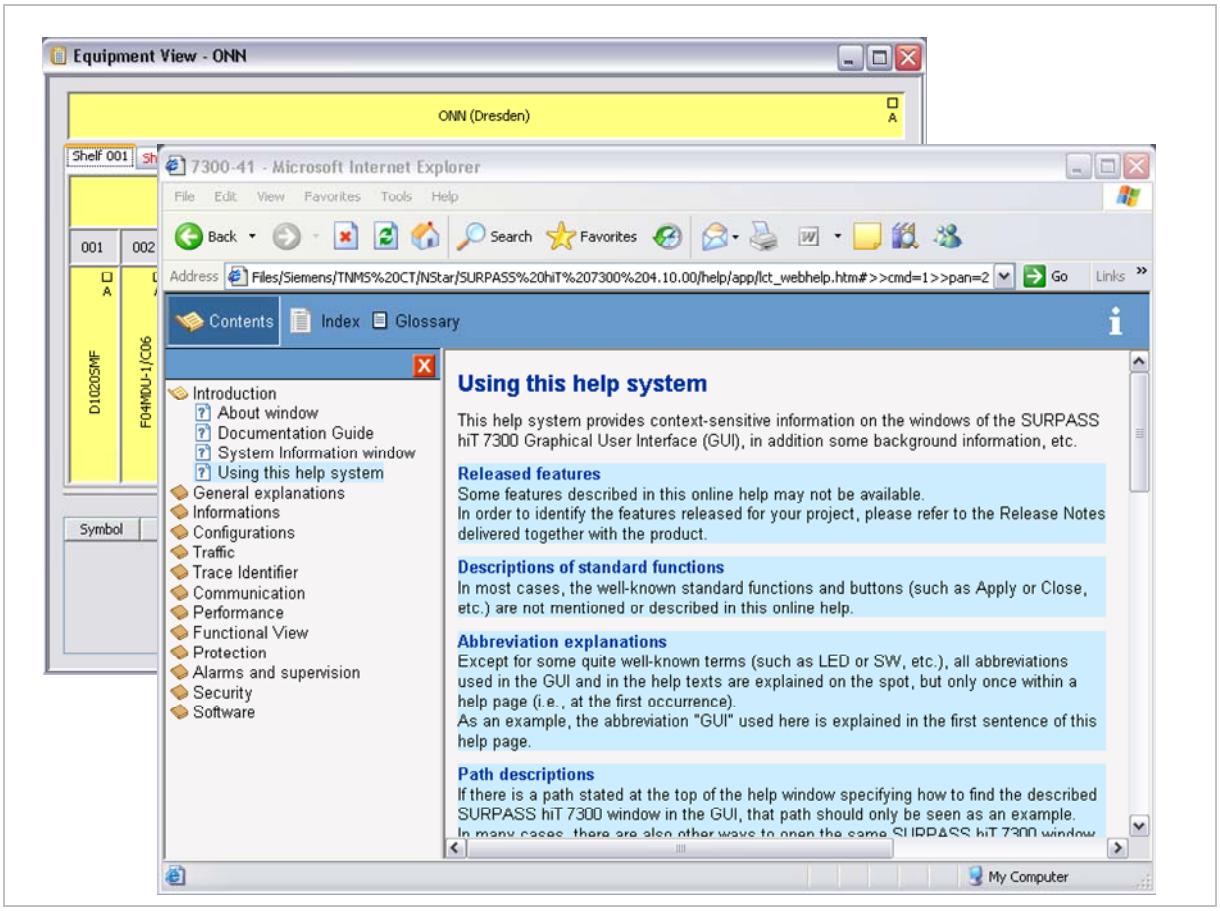
Equipment View - ONN
ONN (Dresden)
Shelf 001
7300-41 - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address Files/Siemens/TNMS%20CT/NStar/SURPASS%20hiT%207300%204.10.00/help/app/lct_webhelp.htm#>>cmd=1>>pan=2
Go Links
Contents Index Glossary
Introduction
About window
Documentation Guide
System Information window
Using this help system
General explanations
Informations
Configurations
Traffic
Trace Identifier
Communication
Performance
Functional View
Protection
Alarms and supervision
Security
Software
Using this help system
This help system provides context-sensitive information on the windows of the SURPASS hiT 7300 Graphical User Interface (GUI), in addition some background information, etc.
Released features
Some features described in this online help may not be available.
In order to identify the features released for your project, please refer to the Release Notes delivered together with the product.
Descriptions of standard functions
In most cases, the well-known standard functions and buttons (such as Apply or Close, etc.) are not mentioned or described in this online help.
Abbreviation explanations
Except for some quite well-known terms (such as LED or SW, etc.), all abbreviations used in the GUI and in the help texts are explained on the spot, but only once within a help page (i.e., at the first occurrence).
As an example, the abbreviation "GUI" used here is explained in the first sentence of this help page.
Path descriptions
If there is a path stated at the top of the help window specifying how to find the described SURPASS hiT 7300 window in the GUI, that path should only be seen as an example.
My Computer

Fig. 4 Online help system

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2 System functions

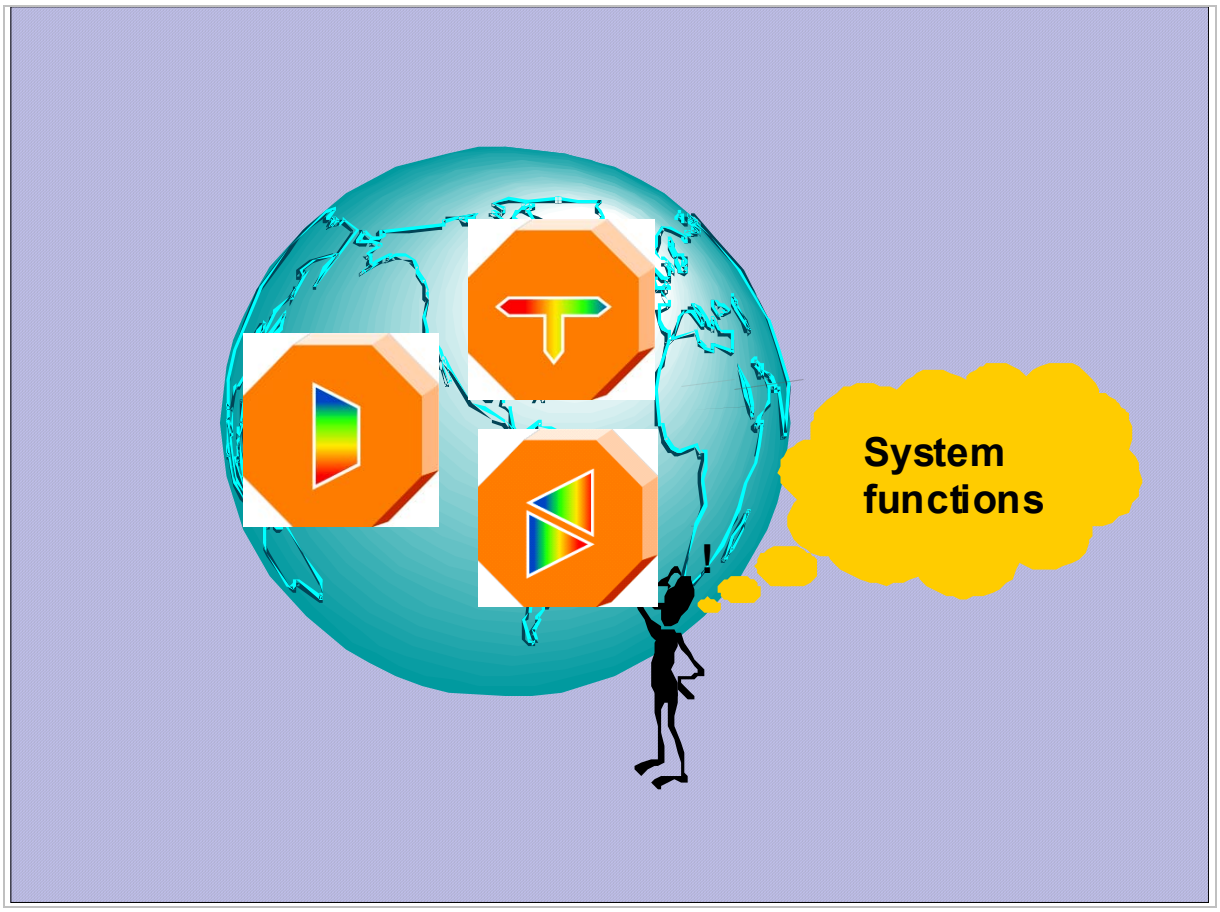

Fig. 5 System functions

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2.1 Transmission wavelengths

The SURPASS hiT 7300 supports 40-channel (with 100 GHz frequency spacing) and 80/96-channel (with 50 GHz frequency spacing) DWDM transmission systems within the C band. The use of a 40-channel or an 80/96-channel plan depends of the customer's needs and network application.

The 40-channel frequency/wavelength plan allows a very flexible network design for various End-of-Life (EOL) optical channel counts from 4 to 40 channels in steps of 4 channel sub-bands. These frequencies/wavelengths are also referred to as standard frequency grid.

SURPASS hiT 7300 80/96-channel DWDM transmission system is using 80 or 96 channels in the C-Band with 50 GHz of channel spacing. These frequencies/wavelengths are created by the combination of the 40/48-channel standard frequency grid with the interleaved set of a 40/48-channel offset frequency grid.

TIP
The 80/96-channel frequency/wavelength plan is not divided into a 4-channel sub-band structure (as the 40-channel frequency/wavelength plan).

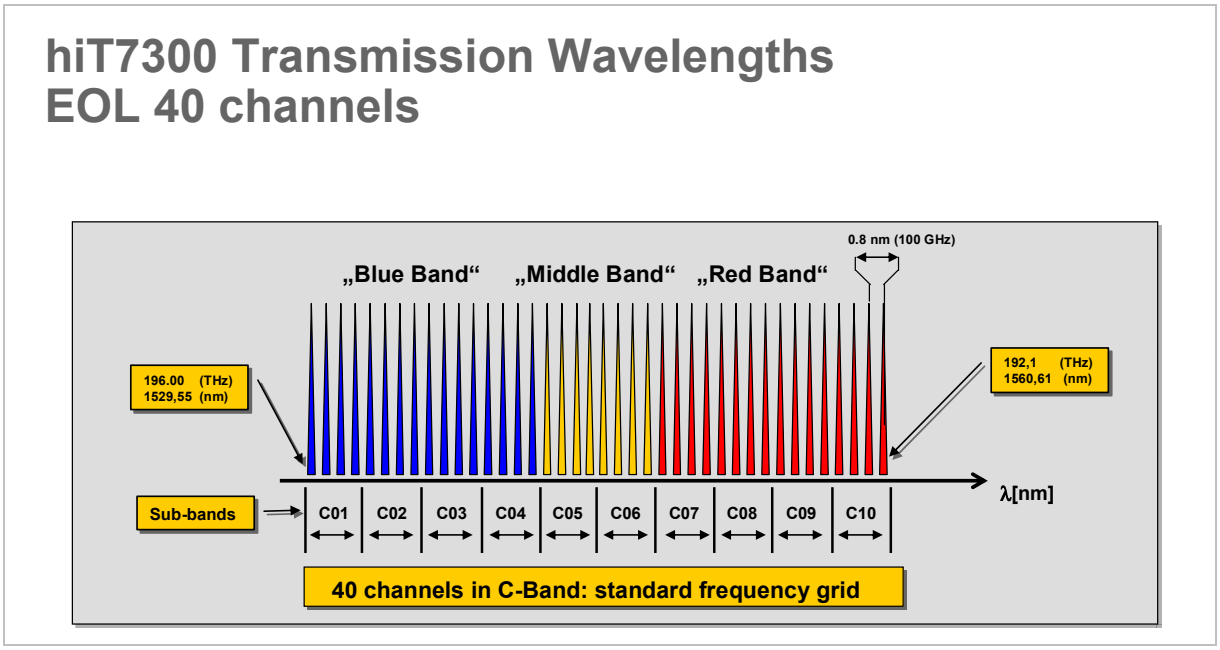

Fig. 6 Transmission wavelengths for EOL 40 channels

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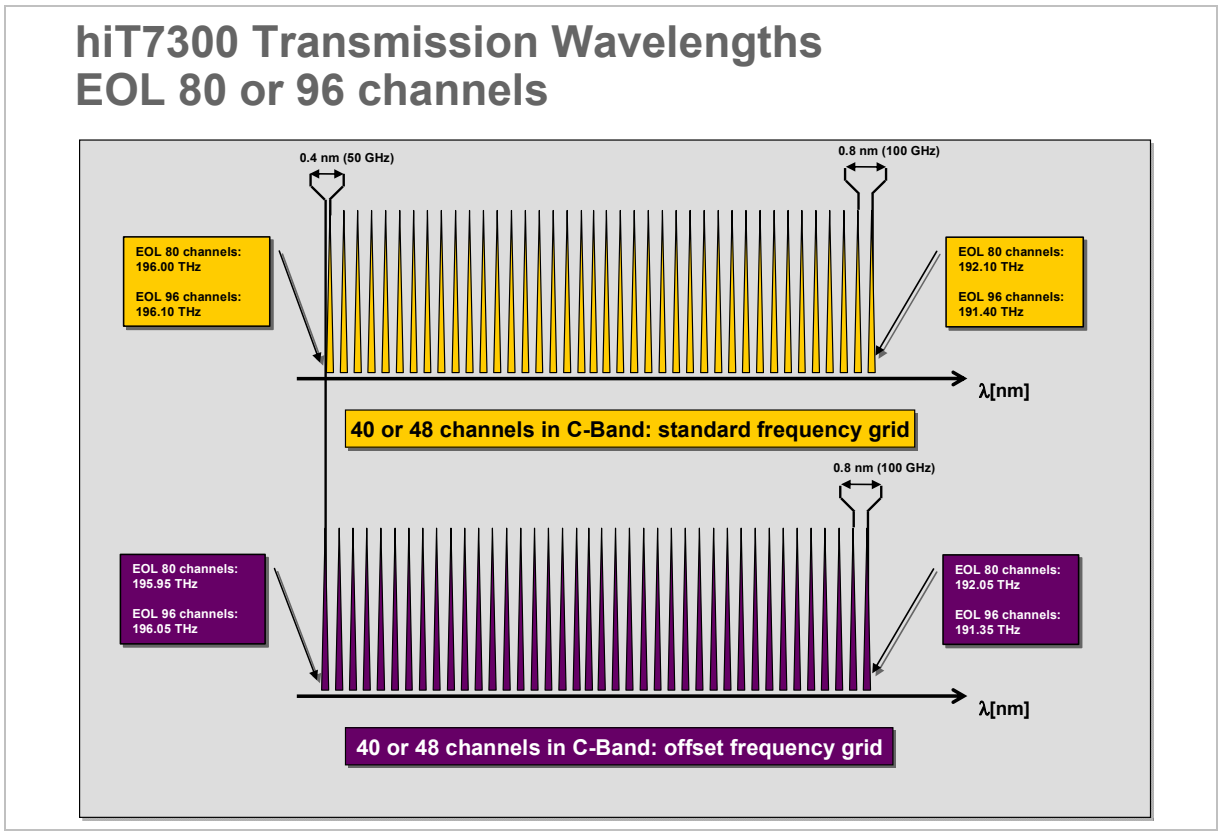

Fig. 7 Transmission wavelengths for EOL 80 or 96 channels

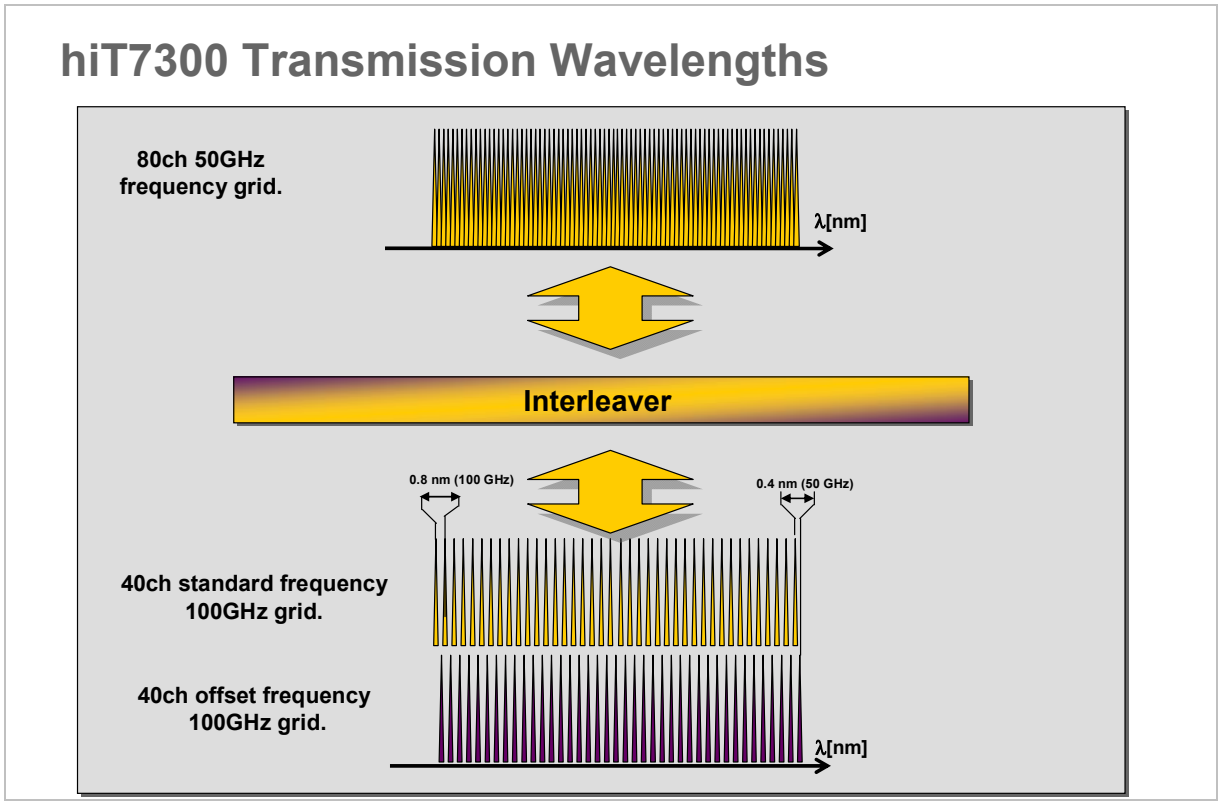

Fig. 8

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The 40 channel frequency/wavelength plan allows for very flexible network design for various End-of-Life (EOL) optical channel counts from 4 channels up to 40 channels in steps of 4 channel sub-bands.

The 40 channel SURPASS hiT7300 system uses a maximum of 40 wavelengths within the C-band, with 100 GHz frequency spacing starting with 1529.55 nm and ending with 1560.61 nm and divided into following groups:

- 16 “blue” wavelengths (C01 to C04 sub-bands).
- 8 “middle” wavelengths (C05 and C06 sub-bands).
- 16 “red” wavelengths (C07 to C10 sub-bands).

All MUX/DMUX cards have fixed wavelength assignment to their physical channel ports. Both thin-film filter for realizing flexible subband structures and arrayed wave-guide (AWG) optical filter technology for full-access to 40-channel frequency grids are available, thereby always meeting cost-effective solutions for each network application. The cards are highly reliable and mostly consisting of passive optical components only.

TIP
The same MUX/DMUX cards are used for ONN terminal applications as well as for all OADM and PXC applications.

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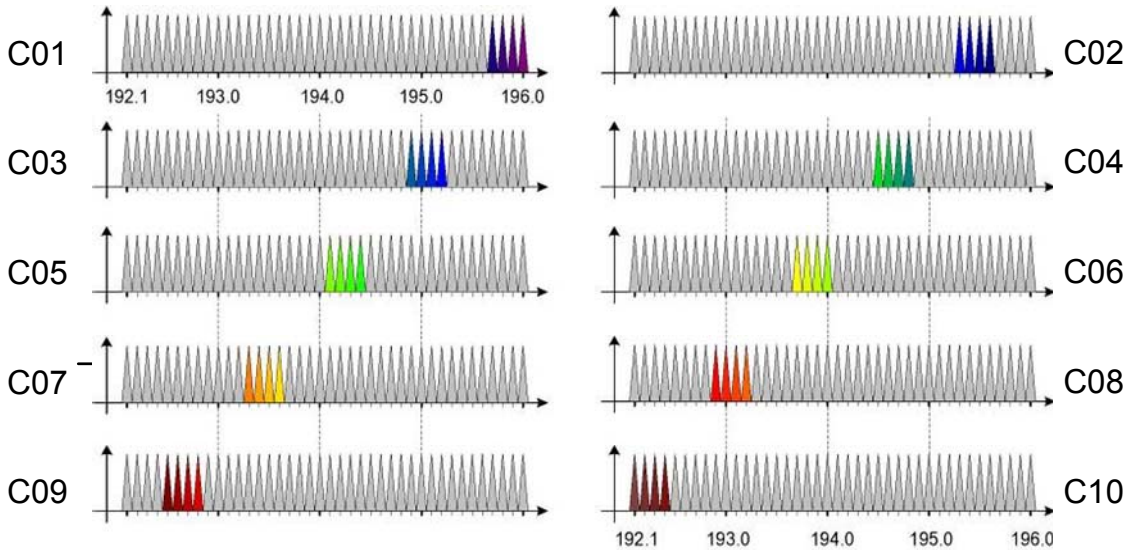
Optical Channel Groups



- 40 channels overall (192.1 … 196.0 THz)
- No band gap

Fig. 9 Optical Channel Groups

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2.2 Optical Multiplexing Scheme

The choice and structure of the optical multiplexing technology for hiT7300 takes into consideration several factors such as the channel granularity requirements, modularity, and subsequent upgradeability. The optical Mux/Demux cards offer very low insertion loss to facilitate links with a large number of ONN's as well as to support ONN's without booster amplifier wherever possible in order to reduce the overall system cost.

SURPASS hiT 7300 supports 40 wavelengths out of the 100 GHz wavelength grid and 80/96 wavelengths out of the 50 GHz wavelength grid according to ITU-T G.692/G.694.1.

The Mux/Demux cards have fixed wavelength to physical port assignment. The cards are highly reliable consisting of the passive optical components including only the electrical components necessary for the card identification. All Mux/Demux cards used for Flexible Terminal/OADM are bidirectional cards, where Mux/Demux cards for FullAccess Terminal/OADM are 40-channel unidirectional or 48-channel bidirectional cards.

TIP
The same Mux/Demux cards are used for the ONN terminal application as well as for the ONN OADM application.

TIP
Cards are bidirectional, only DEMUX direction is shown.

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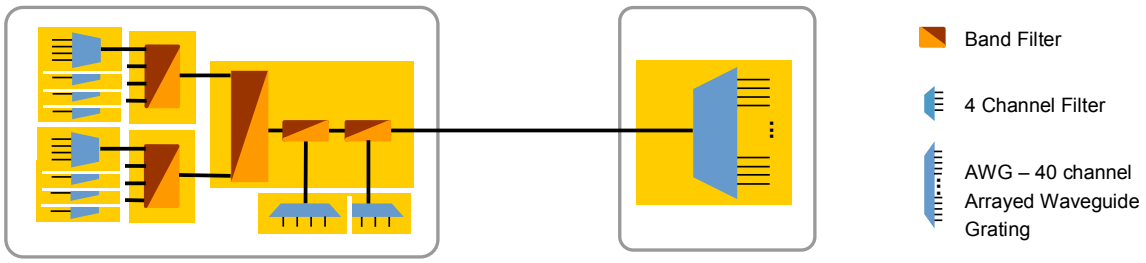
Sub-band filter and AWG filter options for 40 channel terminals



Terminal based on 4- channel sub-bands

- Flexible pay as you grow approach with modular architecture, 4 channel steps
- In service upgrade up to 40 channels end of life

Terminal based on AWG

- Full access to 40 channels from day 1
- 40-ch AWG and 4-ch group filters can be mixed in the network
- Upgrade to 80 channels with add. interleaver and off-set grid AWG

Both fixed filter options – banded and AWG – are fully interoperable

Fig. 10 Optical Multiplexing Scheme- Flexible / AWG

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2.2.1 Flexible Filter structure (cascaded filters)

The filter cards act as multiplexers/demultiplexers by providing the primary wave division or aggregation of all the transponder signals and allowing access (add/drop) to a particular wavelengths or set of wavelengths.

For realizing flexible sub-band structures for multiplexing/demultiplexing of up to 40 channels in standard frequency grid (C-band) with 4-channel granularity there are only 4 types of MUX/DMUX cards needed, which are already supported since R4.0 of hiT 7300:

Optical Multiplexer/Demultiplexer Cards for flexible sub-band structures	
Card function	**Card name**
Red/blue splitter + 2x sub-band multiplexing (bidirectional)	F08SB
4x sub-band multiplexing (bidirectional)	F16SB (red and blue band variant)
1x sub-band filter + 4-channel multiplexing (bidirectional)	F04MDU (10 sub-band variants)
4-Channel multiplexing (bidirectional)	F04MDN (10 sub-band variants)

Optical Multiplexer/Demultiplexer Cards for flexible sub-band structures	
Card function	**Card name**
Red/blue splitter + 2x sub-band multiplexing (bidirectional)	F08SB
4x sub-band multiplexing (bidirectional)	F16SB (red and blue band variant)
1x sub-band filter + 4-channel multiplexing (bidirectional)	F04MDU (10 sub-band variants)
4-Channel multiplexing (bidirectional)	F04MDN (10 sub-band variants)

Fig. 11 Optical Multiplexer/Demultiplexer Cards

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2.2.1.1 F04MDN-1 Filter Cards

The F04MDN-1 card consists of one four channel fixed filter. The card is bidirectional and occupies a single slot. F04MDN-1 is offered in ten different variants (subbands C1-C10) to cover the entire 40 channel wavelength plan.

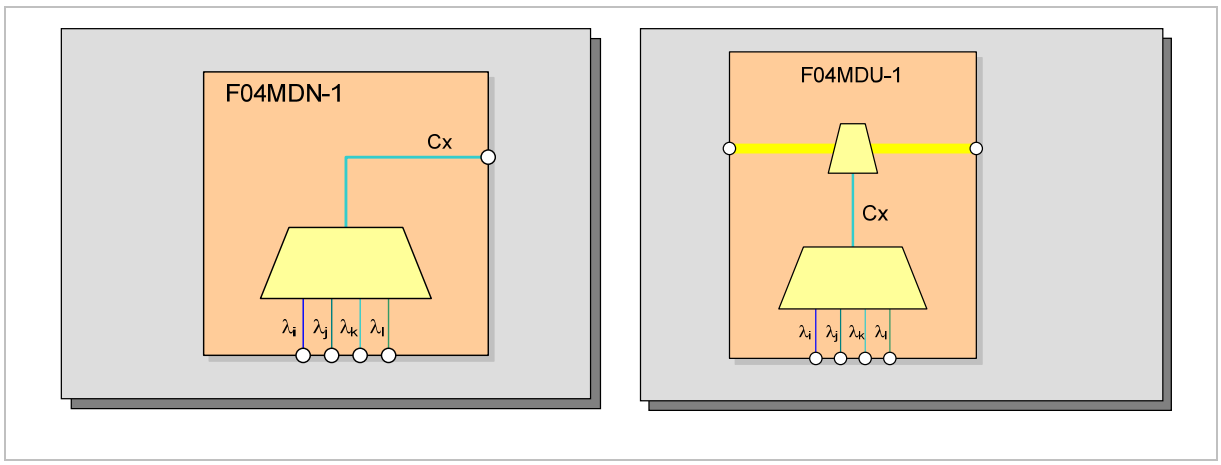

Fig. 12 F04MDN-1 Filter Cards and F04MDU-1 Filter Cards

2.2.1.2 F04MDU-1 Filter Cards

The F04MDU-1 card consists of one band filter and one corresponding four channel fixed filter. The card is bidirectional and occupies a single slot. It is offered in ten different variants (subbands C1-C10) to cover the entire 40 channel wavelength plan.

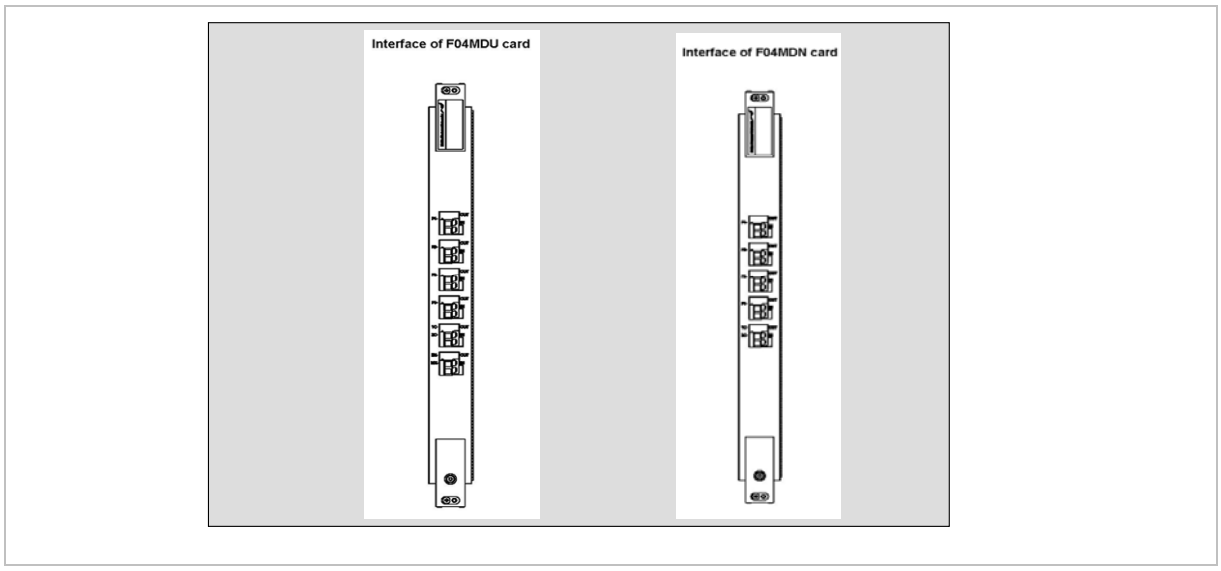

Fig. 13 HW Layout

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2.2.1.3 F08SB-1 Filter Card

The F08SB-1 card consists of a red/blue filter and two band filters. The card is bidirectional and occupies a single slot. It offers two band filters for subbands C5 and C6 and a red/blue filter that separates subbands C1-C4 from subbands C7-C10. There is only one variant of this card.

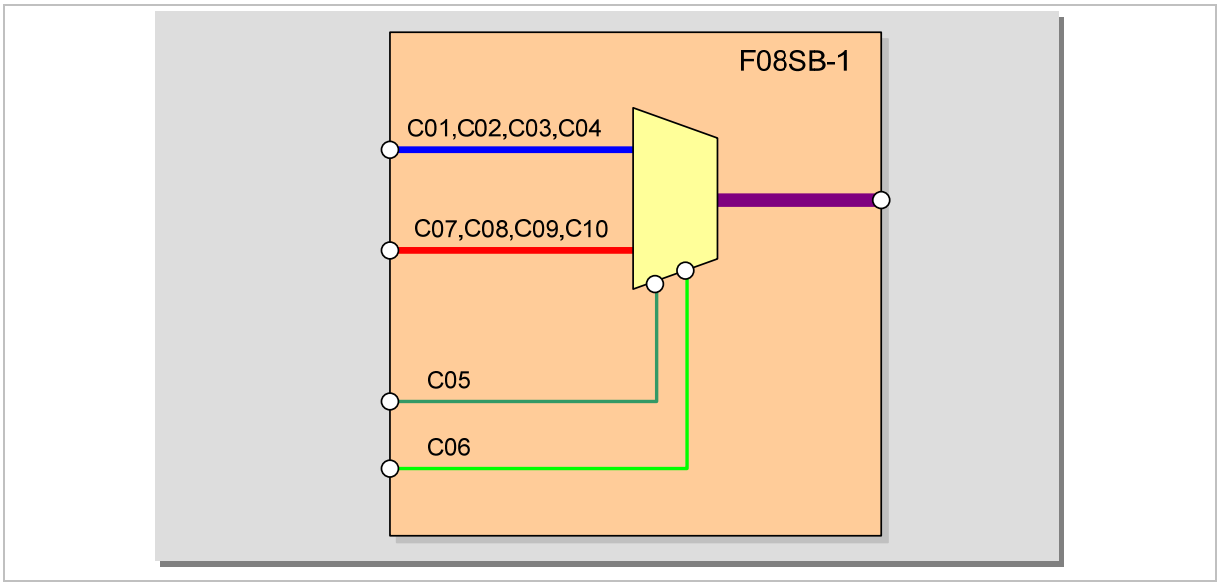

Fig. 14 F08SB-1 Filter Card

2.2.1.4 F16SB-1 Filter Cards

Each F16SB-1 card consists of four cascaded band filters. The card is bidirectional and occupies a single slot. It is offered in two variants for subbands C1-C4 (blue band) and subbands C7-C10 (red band), respectively.

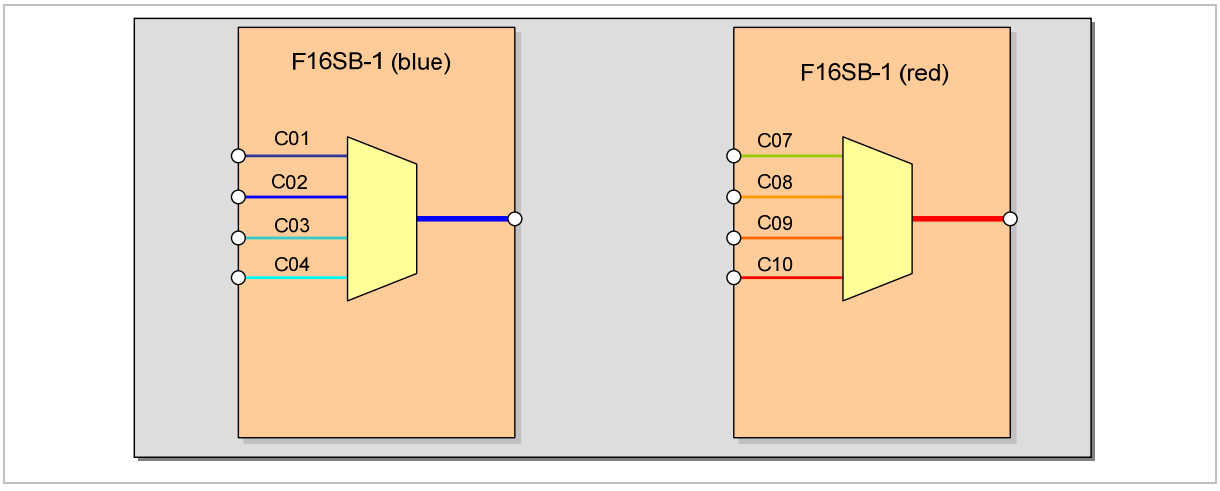

Fig. 15 F16SB-1 Filter Cards

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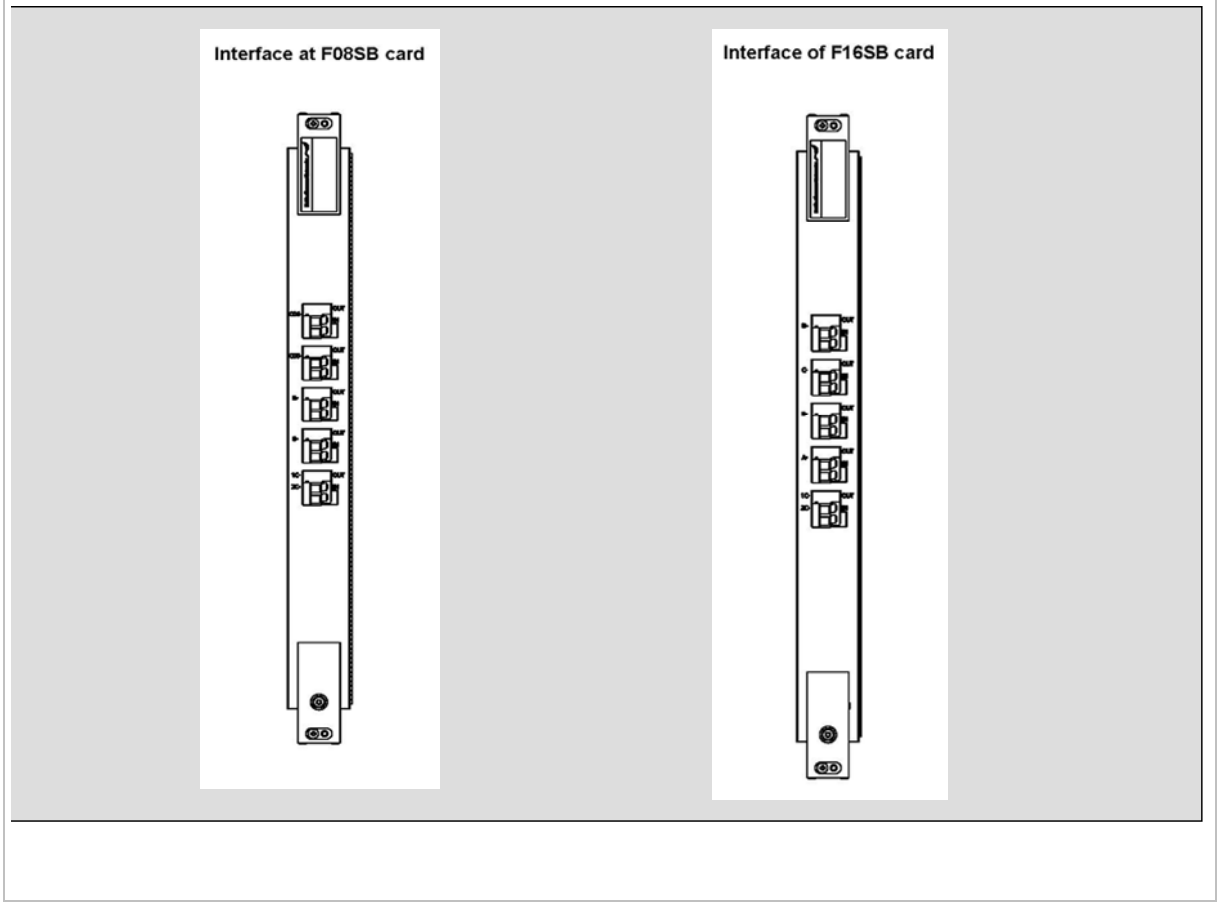

Fig. 16 HW layout

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2.2.2 Fixed Filter structure (AWG filter)

For realizing 40-channel (EOL) systems in standard and offset frequency grid (C-band) with full access to all channels from day 1 (BOL), and for 80 or 96-channel systems the following MUX/DMUX cards are supported in hiT 7300:

Optical Multiplexer/Demultiplexer Cards for 40/80-channels full access scheme	
Card function	**Card name**
40-channel unidirectional multiplexing/demultiplexing for 100GHz Standard frequency grid or Offset frequency grid	F40/S or /O
40-channel unidirectional multiplexing/demultiplexing and per channel VOA's for 100GHz Standard frequency grid or Offset frequency grid	F40V/S or /O
40-channel multiplexing for 100GHz frequency grid, per channel monitor diodes, /S and /O	F40MP/S or /O
40-channel multiplexing for 100GHz frequency grid, per channel monitor diodes and VOAs, /S and /O	F40VMP/S or /O
80-channel split coupler and drop interleaver (unidirectional)	F80DCI
80-channel interleaver (bidirectional)	F80MDI

Optical Multiplexer/Demultiplexer Cards for 96-channels full access scheme	
Card function	**Card name**
48-channel unidirectional multiplexing and demultiplexing for 100GHz Standard frequency grid	F48MDP/S
48-channel unidirectional multiplexing and demultiplexing for 100GHz Offset frequency grid	F48MDP/O

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Optical Multiplexer/Demultiplexer Cards for 40/80-channels full access scheme	
Card function	**Card name**
40-channel unidirectional multiplexing/demultiplexing for 100GHz Standard frequency grid or Offset frequency grid	F40/S or /O
40-channel unidirectional multiplexing/demultiplexing and per channel VOA's for 100GHz Standard frequency grid or Offset frequency grid	F40V/S or /O
40-channel multiplexing for 100GHz frequency grid, per channel monitor diodes, /S and /O	F40MP/S or /O
40-channel multiplexing for 100GHz frequency grid, per channel monitor diodes and VOAs, /S and /O	F40VMP/S or /O
80-channel split coupler and drop interleaver (unidirectional)	F80DCI
80-channel interleaver (bidirectional)	F80MDI

Fig. 17 Optical Multiplexer/Demultiplexer Cards of EOL 40/80 channels

Optical Multiplexer/Demultiplexer Cards for 96-channels full access scheme	
Card function	**Card name**
48-channel unidirectional multiplexing and demultiplexing for 100GHz Standard frequency grid	F48MDP/S
48-channel unidirectional multiplexing and demultiplexing for 100GHz Offset frequency grid	F48MDP/O

Fig. 18 Optical Multiplexer/Demultiplexer Cards of EOL 96 channels

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2.2.2.1 F40-1/S and F40-/O Filter Cards

Each F40-1/x filter cards consist of a 40-channel fixed filter based on temperature-controlled arrayed waveguide grating (AWG) technology, which performs multiplexing or demultiplexing of 40 channels in 100 GHz spaced standard frequency grid (F40/S) or 100 GHz spaced offset (50 GHz shifted) frequency grid (F40/O), respectively.

The F40-1/x card is unidirectional and performs either an optical multiplexing or demultiplexing.

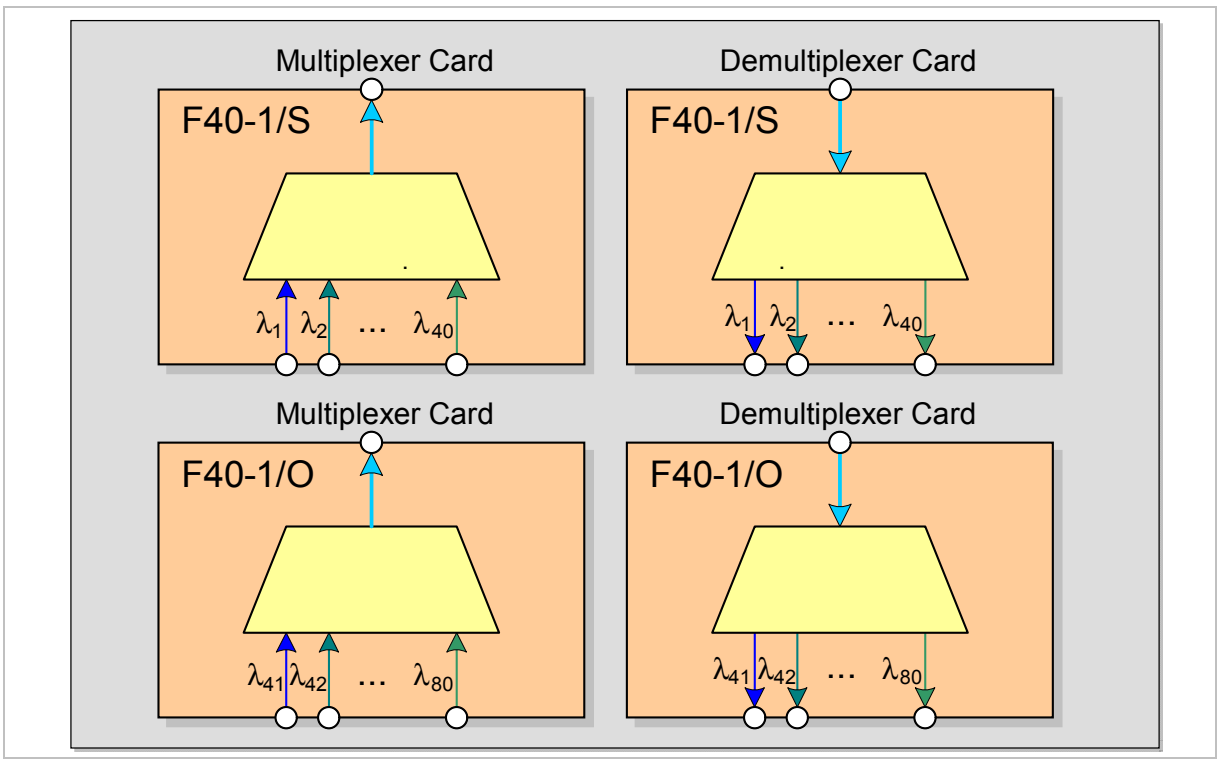

Fig. 19 F40-1/x Filter Cards

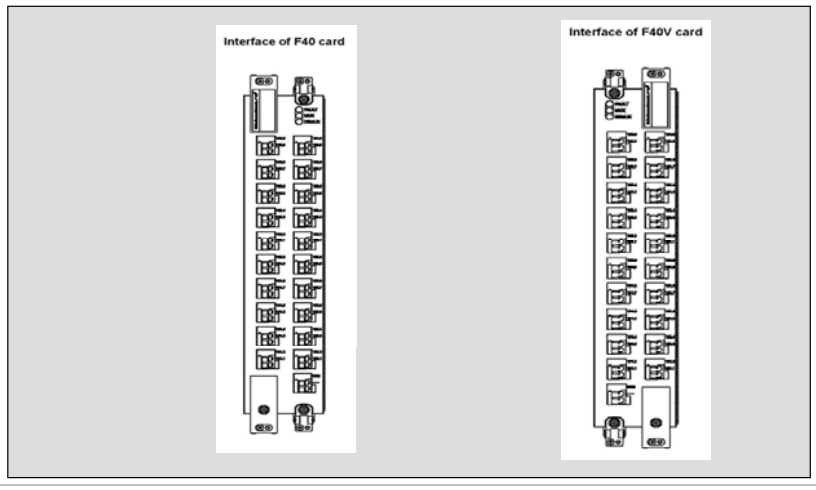

Fig. 20 HW Layout

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2.2.2.2 F40V/S and F40V/O Filter Cards

The F40V-1/x card consists of a 40-channel fixed filter based on temperature-controlled AWG technology. The F40V-1/x performs multiplexing or demultiplexing of 40 channels in 100 GHz spaced standard frequency grid (F40V-1/S) or 100 GHz spaced offset (50 GHz shifted) frequency grid (F40V-1/O), respectively.

In addition to multiplexing/demultiplexing each F40V-1/x contains a Variable Optical Attenuator (VOA) for each individual input/output channel. The VOAs are used in the optical channel power pre-emphasis (in case the F40V-1/x card is used as multiplexer) or drop channel power adjust (in case the F40V-1/x card is used as demultiplexer), therefore allowing a very compact and cost-effective solution with high channel count while, achieving highly automated network commissioning at the same time.

The F40-1V/x card is unidirectional and performs either an optical multiplexing or demultiplexing like the F40/x each F40V/x card provides 41 optical front connectors within 21 duplex LC/PC connectors on the front panel for access to all 40 channel ports and the aggregation port, it occupies 2 slots (2x 30mm).

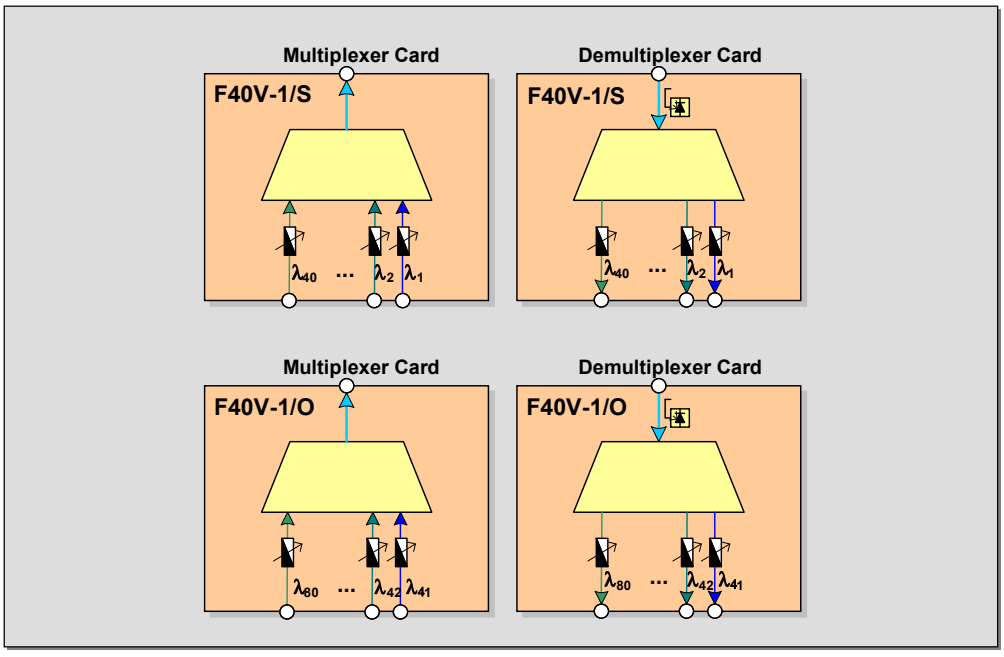

Fig. 21 F40V/S and F40V/O Filter Cards

TIP

When used as a demultiplexer, an optical input power monitor is provided for detection of loss-of-signal and laser safety control.

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2.2.2.3 F48MDP-1/S and F48MDP-1/O Filter Cards

The F48MDP-1/x card consists of a 48-channel fixed filter based on AWG technology. The F48MDP-1/x is a bidirectional card that performs multiplexing or demultiplexing of 48 channels in spaced standard frequency grid (F48MDP-1/S) or spaced offset (50 GHz shifted) frequency grid (F48MDP-1/O).

The input port of the demultiplexing incorporates a monitor diode for LOS detection and signaling to Laser Safety bus and to Fault-Management. The demultiplexer has a monitor point for service and optional MCP access.

The multiplexing part of the card has in each input port, monitors for Automatic Port Connection Detection (APDC), power level measurement and LOS detection.

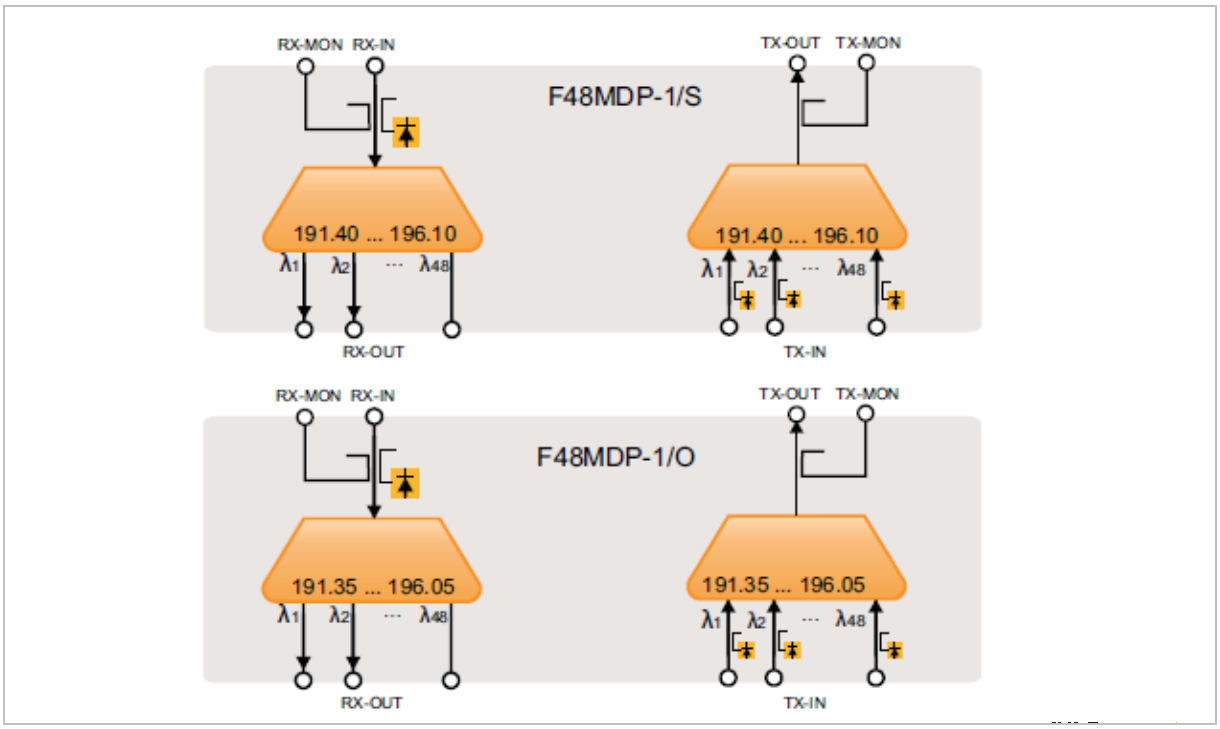

Fig. 22 F48MPD-1/x Filter Cards

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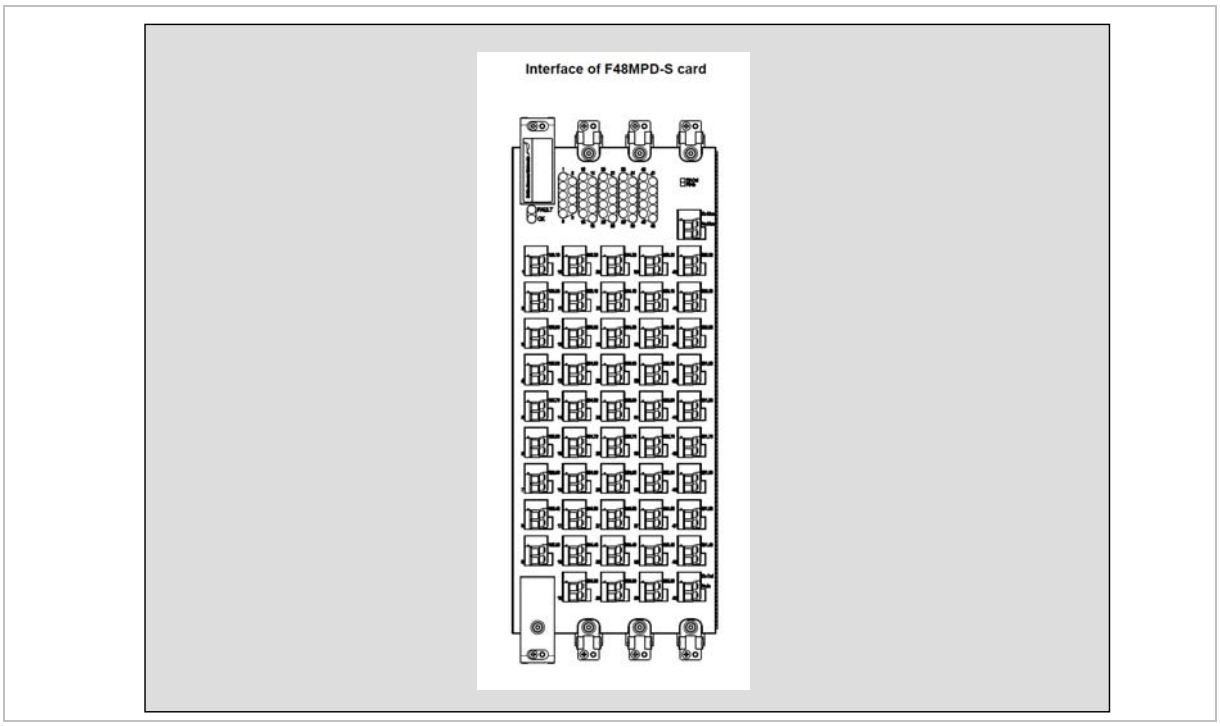

Fig. 23 HW Layout

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2.2.3 Wavelength-Selective Switch Cards

The filter cards act as multiplexers/demultiplexers by providing the primary wave division or aggregation of all the transponder signals and allowing access (add/drop) to a particular set of wavelengths from an optical fiber while passing the remaining wavelengths. Line side wavelengths require translation to client side equipment via the transponder card.

The following Wavelength-Selective Switch cards are supported in hiT 7300:

Wavelength-Selective Switch Cards			
Card name	**Usage** Optical multiplexer of	**Architecture**	**Communication type**
F40MR-1	a ROADM	PLC-WSS	Bidirectional
F02MR-1	an ONN-R2	MEMS-WSS	Bidirectional
F08MR-1	reconfigurable PXC	MEMS-WSS	Bidirectional
F06DR80-1	Optical demultiplexer of a reconfigurable PXC	MEMS-WSS	Unidirectional
F06MR80-1	a reconfigurable PXC	MEMS-WSS	Unidirectional
F09DR80-1	Optical demultiplexer of a reconfigurable PXC	PLC-WSS	Unidirectional
F09MR80-1	a reconfigurable PXC	PLC-WSS	Unidirectional
F09MDRT-1/S	an ONN-RT or ONNX	Tunable WSS	Bidirectional
F09MDRT-1/O	an ONN-RT or ONNX	Tunable WSS	Bidirectional
F09MDR96-1	an ONN-X96	Tunable WSS	Bidirectional
O09CC-1	an ONN-X96	Coupler card for color- and directionless PXC	Bidirectional
F80DCI-1	Optical demultiplexer of a ROADM	Interleaver filter and splitter	Unidirectional
F80MDI-1	Optical multiplexer or demultiplexer	Interleaver filters	Bidirectional

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Wavelength-Selective Switch Cards			
Card name	**Usage** Optical multiplexer of …	**Architecture**	**Communication type**
F40MR-1	a ROADM	PLC-WSS	Bidirectional
F02MR-1	an ONN-R2	MEMS-WSS	Bidirectional
F08MR-1	reconfigurable PXC	MEMS-WSS	Bidirectional
F06DR80-1	Optical demultiplexer of a reconfigurable PXC	MEMS-WSS	Unidirectional
F06MR80-1	a reconfigurable PXC	MEMS-WSS	Unidirectional
F09DR80-1	Optical demultiplexer of a reconfigurable PXC	PLC-WSS	Unidirectional
F09MR80-1	a reconfigurable PXC	PLC-WSS	Unidirectional
F09MDRT-1/S	an ONN-RT or ONN-X	Tunable WSS	Bidirectional
F09MDRT-1/O	an ONN-RT or ONN-X	Tunable WSS	Bidirectional
F09MDR96-1	an ONN-X96	Tunable WSS	Bidirectional
O09CC-1	an ONN-X96	Couple card for colorless and directionless PXC	Bidirectional
F80DCI-1	Optical demultiplexer of a ROADM	Interleaver filter and splitter	Unidirectional
F80MDI-1	Optical multiplexer or demultiplexer	Interleaver filters	bidirectional

Fig. 24 Wavelength-Selective Switch Cards

Wavelength-Selective Switch Cards								
Card name	**ONN-R**	**ONN-R2**	**ONN-R80**	**ONN-RT**	**ONN-RT80**	**ONN-X**	**ONN-X80**	**ONN-X96**
F40MR-1	X							
F02MR-1		X						
F08MR-1			X			X		
F06DR80-1							X	
F06MR80-1							X	
F09DR80-1							X	
F09MR80-1							X	
F09MDRT-1/S				X	X			
F09MDRT-1/O					X			
F09MDR96-1								X
O09CC-1								X
F80DCI-1			X					
F80MDI-1					X			

Fig. 25 Wavelength-Selective Switch Cards

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2.2.3.1 F40MR-1

SURPASS hiT 7300 supports wavelength selective switching for building a ROADM providing full access to 40 optical channels. The key component for this application is the F40MR-1 card which includes an integrated Planar Lightwave Circuit-Wavelength Selective Switch (PLC-WSS) with low insertion loss, providing a remotely (via software) reconfigurable optical switching function per individual wavelength.

The input DWDM signal from the line interface (optical pre-amplifier) is split into express traffic and local drop traffic. The express direction provides an optical input power monitor for detection of loss-of-signal and laser safety control.

The output DWDM signal toward the line interface (booster or booster-less interface) of the PLC-WSS, results from a 40-channel multiplexing. These 40 multiplexed channels are individually selectable (via software) between the 40 incoming express channels and the 40 local add channels.

For each optical channel to be transmitted, a VOA and an optical power monitor diode are available.

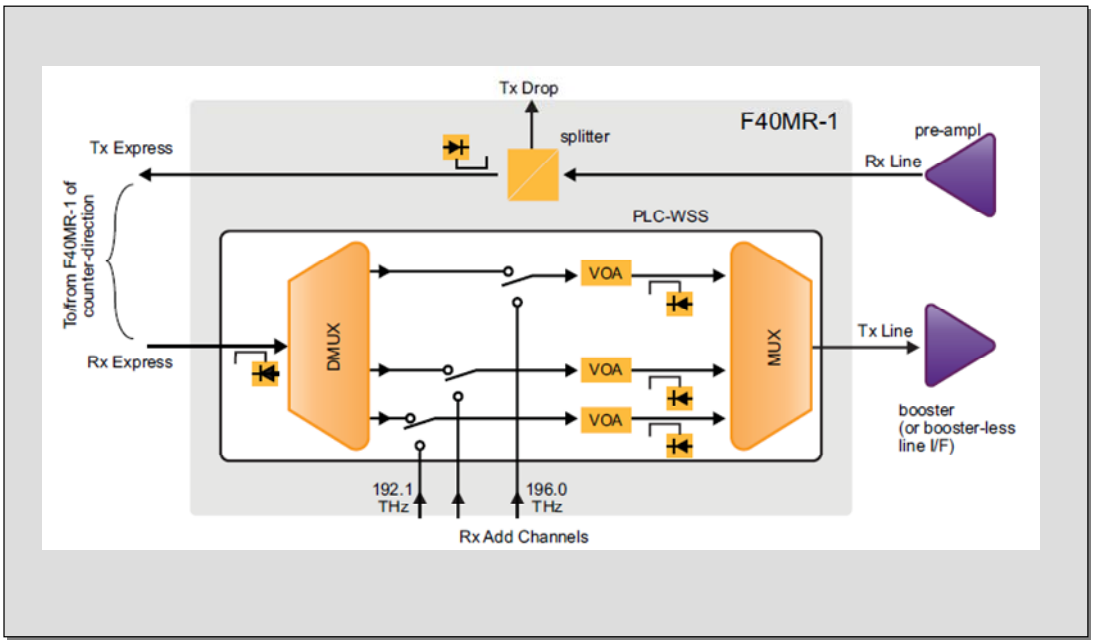

Fig. 26 F40MR-1 card structure

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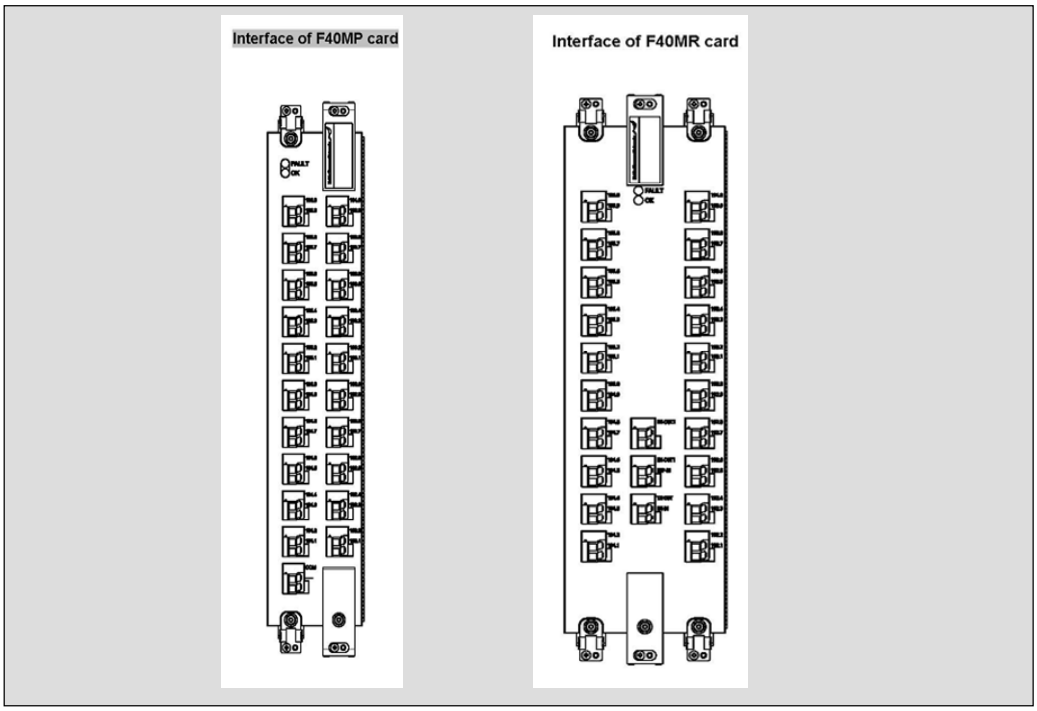

Fig. 27 F40MR-1 card structure- HW layout

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2.2.3.2 F02MR-1

SURPASS hiT 7300 supports wavelength selective switching for building a cost optimized nodal degree 2 ROADM (i.e., ONN-R2) providing full access to 40 optical channels.

The key component for this application is the F02MR-1 card which includes in the transmission path an integrated 2:1 Micro-Electro-Mechanical System - Wavelength Selective Switch (MEMS-WSS) module, providing a remotely (via software) reconfigurable optical switching function per individual wavelength.

The incoming signals of the cross-connect are switched with the WSS module on the common output which is followed by a booster amplifier. One of the inputs of the WSS is connected to the output of a mux filter where the local add channels are inserted.

In the receiver path, the incoming signal from the pre-amplifier is launched into a 1x2 splitter with a 40/60 splitting ratio. At the higher output port, a demux filter (F40-1/S) can be connected for local drop traffic. The other port is the output of the cross-connect. At both inputs of the WSS and the C-COM port of the splitter, LOS monitors are used for supervision. Also a power monitor is included at the splitter drop output.

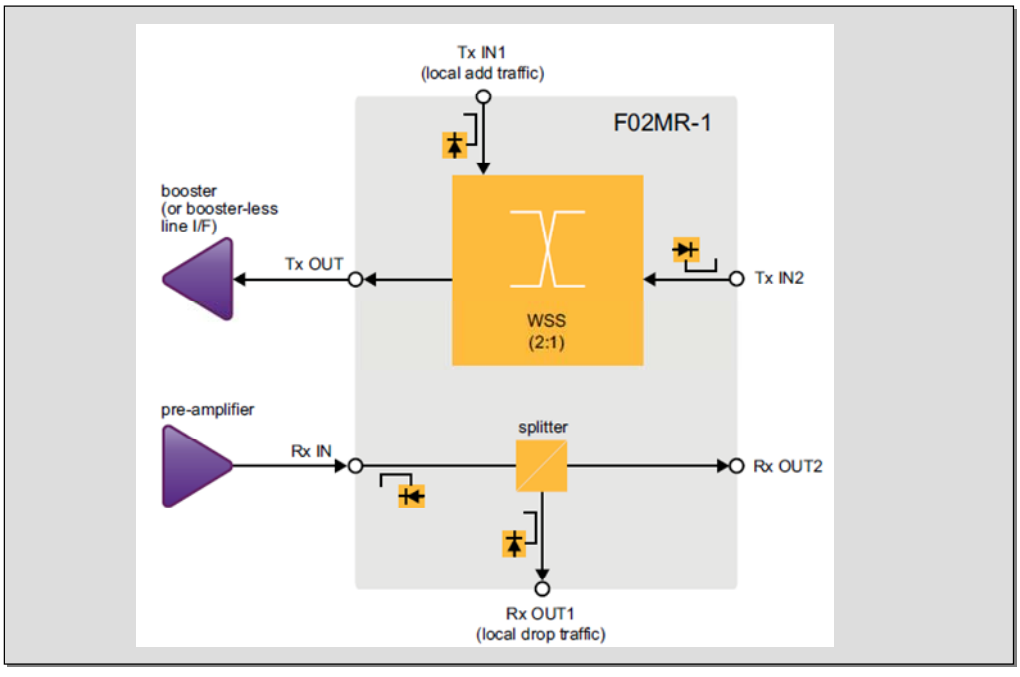

Fig. 28 F02MR-1 card structure

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2.2.3.3 F08MR-1

SURPASS hiT 7300 supports wavelength selective switching for building a multi-degree 40-channel PXC providing full access to 40 optical channels. The key component for this application is the F08MR-1 card which includes an integrated 8:1 MEMS-WSS module, providing a remotely (via software) reconfigurable optical switching function per individual wavelength.

The input DWDM signal from the line interface (optical pre-amplifier) is split into 7 crossconnect outputs and 1 local drop traffic output. The drop output also provides an optical input power monitor for detection of Loss Of Signal (LOS) and laser safety control.

The **WSS module** collects DWDM traffic from 7 other line ports and 1 local add traffic input, and performs arbitrary pass-through switching for any wavelength, of the 8 input ports, toward its output port.

The internal cross-connect traffic ports from different F08MR-1 cards (of different line directions) can be interconnected to allow a configurable pass-through traffic between arbitrary line directions.

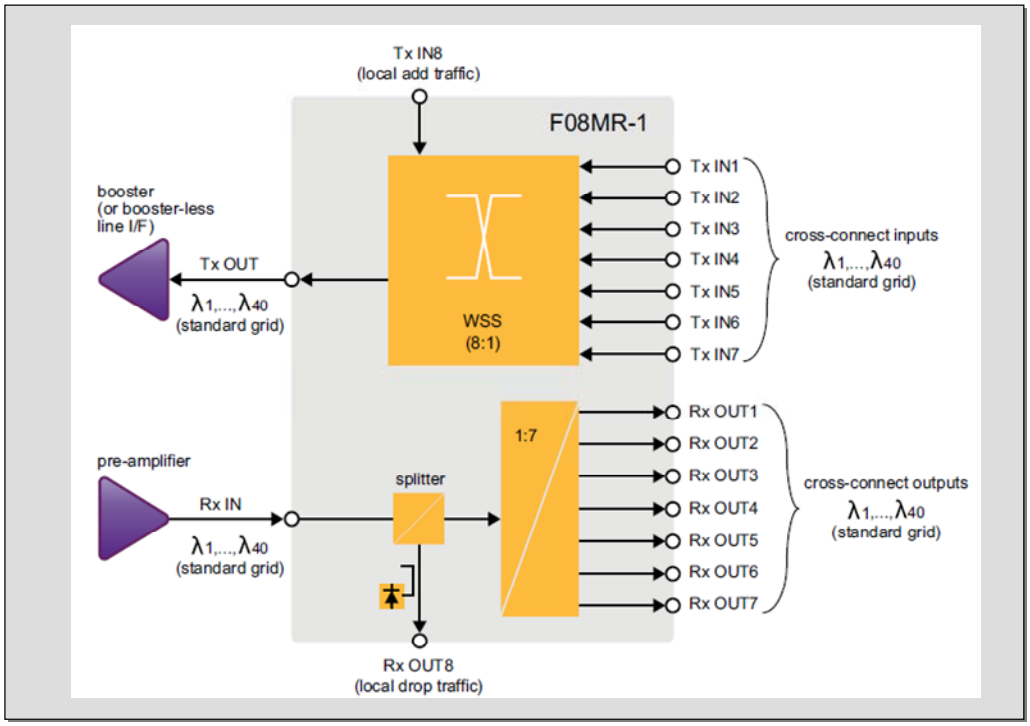

Fig. 29 F08MR-1 card structure

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2.2.3.4 F09MDRT-1/S and F09MDRT-1/O

The F09MDRT-1/x is a bidirectional tunable WSS card suitable **for ONN-RT** and ONNRT80 configurations.

Each drop channel of the WSS is **tunable** and **remotely configurable**. The F09MDRT-1/x contains a **1:9 WSS with 100GHz spacing** and a **9:1 coupler structure**. The WSS input port and all coupler input ports C1…C9 are monitored for LOS, and are equipped with per channel VOAs.

In order **to support 80-channel operation** with 50GHz spacing, **two cards** are required (a standard **F09MDRT-1/S card** and an offset **F09MDRT-1/O** card). These two cards are operated in parallel **using an interleaver** to **support a total of 16 tunable add/drop** channels per each transmission direction.

The F9MDRT-1/x card can be used in a ROADM application (**mainly for Metro core networks**) or as a non-directional terminal in an ONN-X configuration.

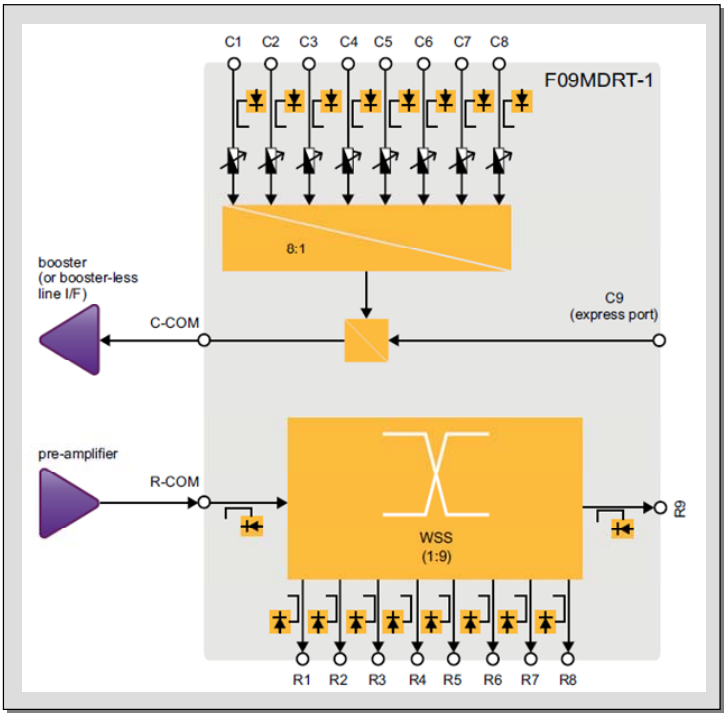

Fig. 30 F09MDRT-1 card structure

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2.2.3.5 F06DR80-1 and F06MR80-1

The F06DR80-1 and F06MR80-1 cards allow SURPASS hiT 7300 to support wavelength selective switching for building a **multi-degree 80-channel PXC** providing full access to 80 optical channels. The F06DR80-1 and F06MR80-1 cards include an **integrated 1:6 (in the F06DR80-1) or 6:1 (in the F06MR80-1) MEMS-WSS module**, providing a remotely (via software) reconfigurable optical switching function per individual wavelength.

The input DWDM signal from the line interface (optical pre-amplifier) is switched per wavelength by the MEMS-WSS module on the F06DR80-1 card, either to any of the cross-connect output ports or to one of the two local drop traffic ports, which are already divided into two 40-channel frequency groups of the standard and offset grids, respectively, so that **no interleaver is required**.

The F06DR80-1 provides a **LOS monitor** for the input signal is provided for laser safety control at the line interface and each output port is also supervised for over-power detection to ensure laser safety of hazard level 1M.

The output DWDM signal to a line interface (optical booster) is created by the MEMSWSS module on the F06MR80-1 card, which switches per wavelength from any of the cross-connect input signals or from one of the two local add traffic ports, which are already divided into two 40-channel frequency groups of standard and offset grids.

The internal cross-connect traffic ports from the F06DR80-1 and F06MR80-1 cards (of different line directions) can be interconnected to allow a configurable pass-through traffic between arbitrary line directions.

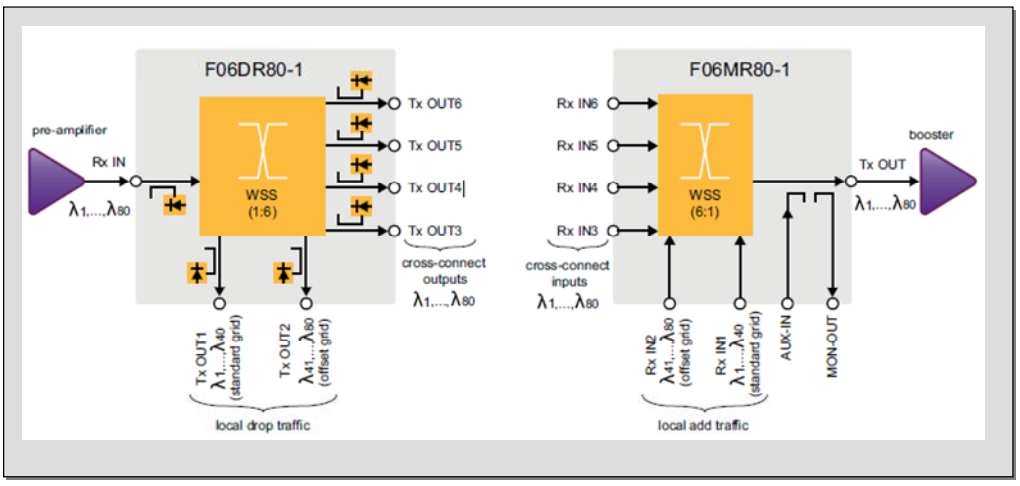

Fig. 31 F06DR80-1 and F06MR80-1 cards structure

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2.2.3.6 F09DR80-1 and F09MR80-1

The F09DR80-1 and F09MR80-1 cards allow SURPASS hiT 7300 to support wavelength selective switching for building a **multi-degree 80-channel PXC** providing full access to 80 optical channels. The F09DR80-1 and F09MR80-1 cards include an **integrated 1:9 (in the F09DR80-1) or 9:1 (in the F09MR80-1) PLC-WSS module**, providing a remotely (via software) reconfigurable optical switching function per individual wavelength.

The F09DR80-1 card is used as a demultiplexer in an ONN-X80 (in a PXC architecture **with nodal degree of up to 8**). It includes a monitor diode at the input port for LOS detection and signaling via LSB and monitor diodes at the 9 outputs ports for overpower detection and signaling via LSBus.

The F09MR80-1 card is used as a multiplexer in an ONN-X80 (in an 8x8 PXC architecture) and in the ONN-R80.

TIP

The F09DR80-1 and F09MR90-1 cards can be used as spares of the F06DR80-1 and F06MR80-1 cards, respectively.

The combination of both the F09DR80-1 and F09MR80-1 cards allows a **higher extinction ratio and better reach** when compared to a case where a combination of WSS and power splitter is used. This measure is of advantage for the narrow channel spacing.

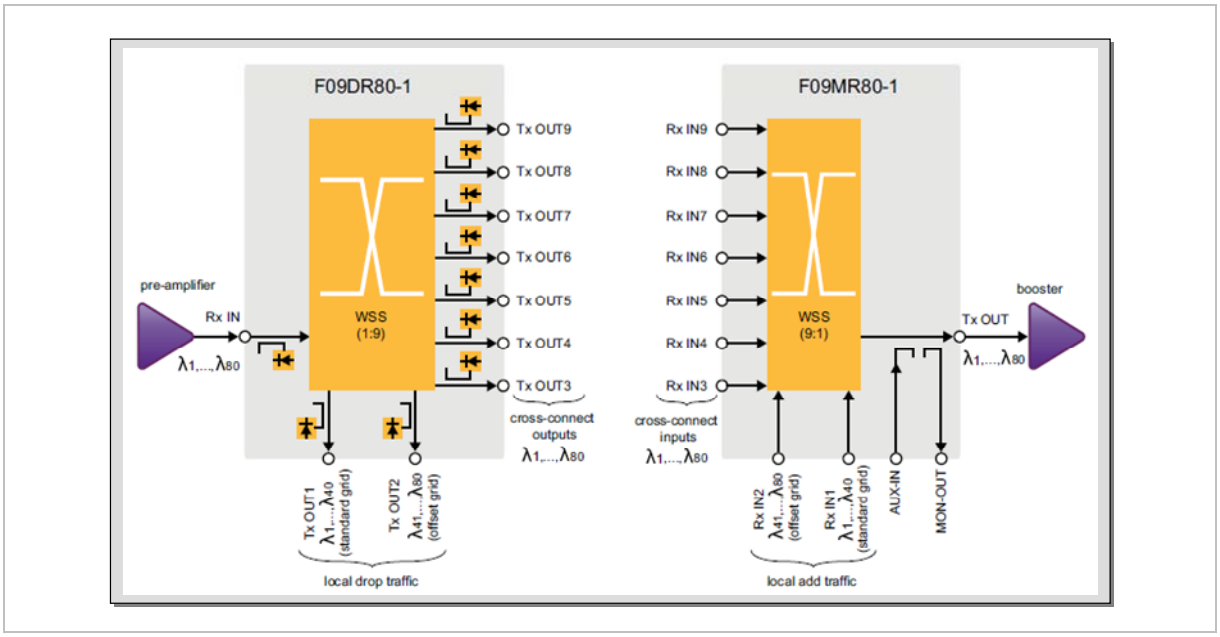

Fig. 32 F09DR80-1 and F09MR80-1 cards structure

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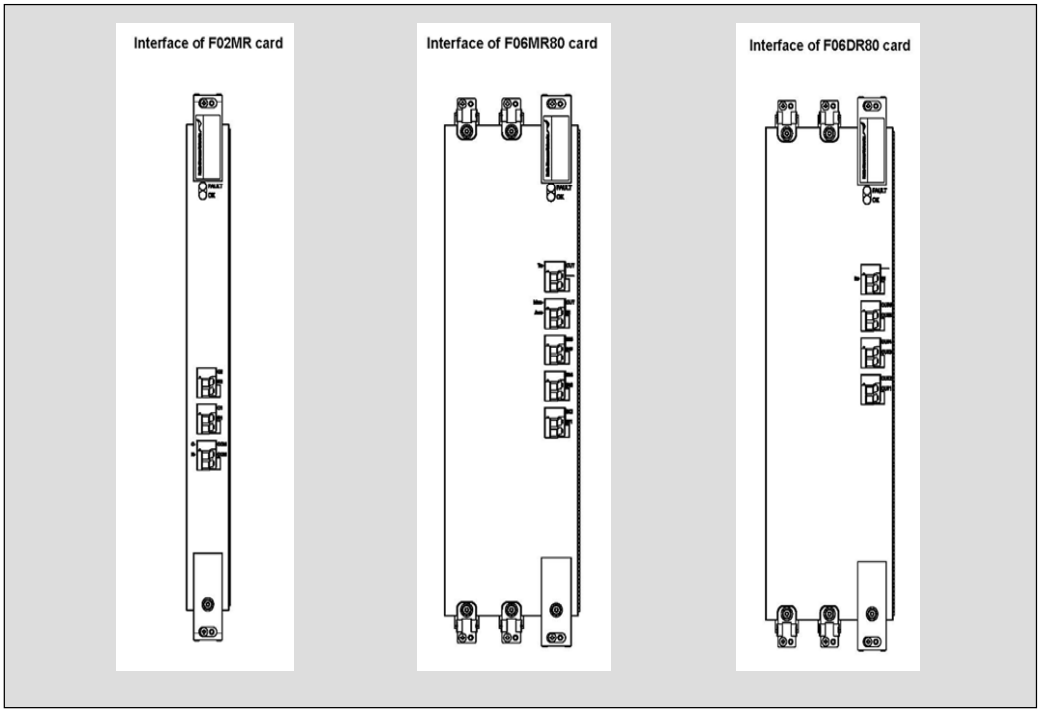

Fig. 33 F09DR80-1 and F09MR80-1 cards structure HW

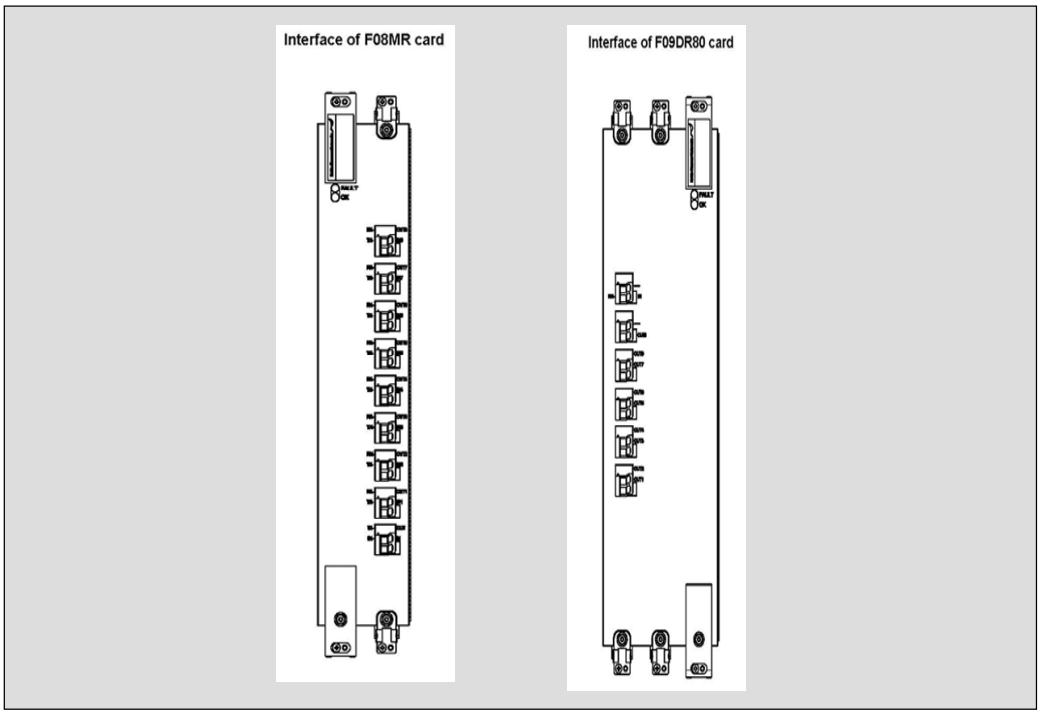

Fig. 34 HW layout

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2.2.3.7 F09MDR96-1

The F09MDR96-1 is a bidirectional tunable WSS card with colorless ports capable of multiplexing and demultiplexing up to 96 channels. Each card is constituted by two WSS modules for multiplexing and demultiplexing 9 channels on 50 GHz spacing.

Each card, in the demultiplexing WSS module, includes a monitor diode at the input port for LOS detection and signaling to laser safety bus and to Fault-Management. At each output port a monitor diode for overpower detection and signaling to controller and to laser safety bus.

The Multiplexing WSS has in each input port, monitors for Automatic Port Connection Detection (APDC), power level measurement and LOS detection.

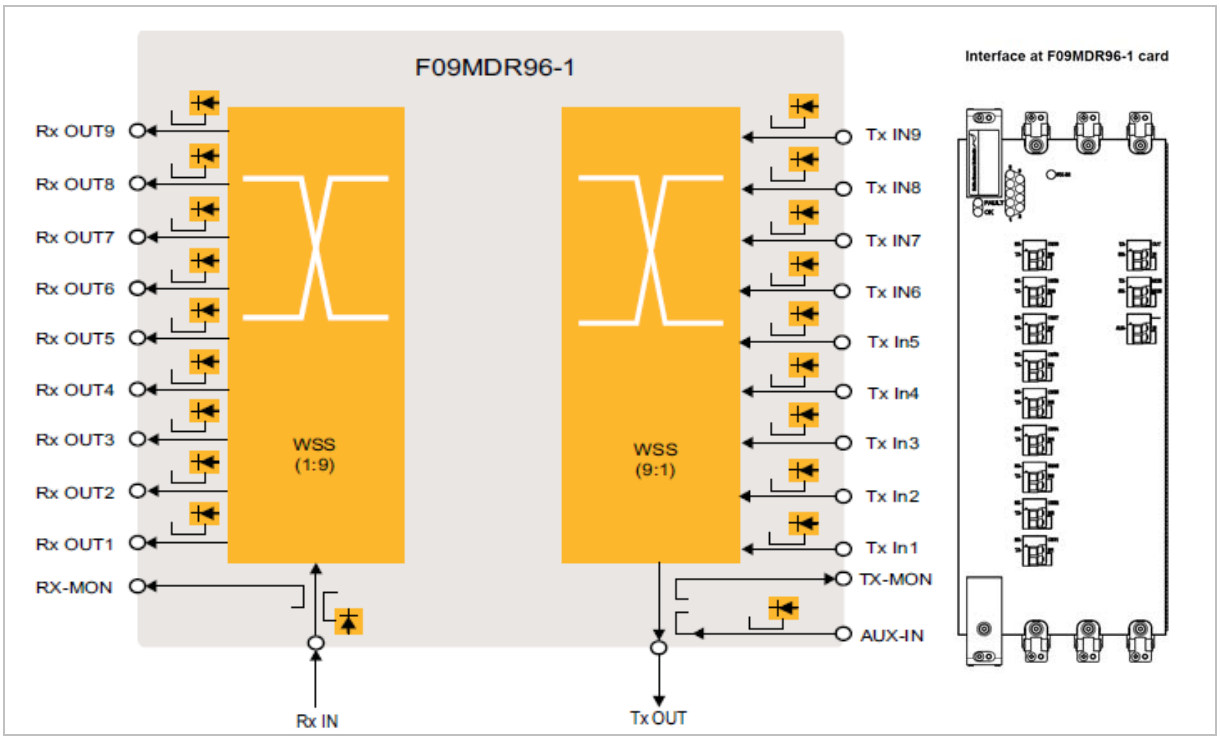

Fig. 35 F09MDR96-1 card structure

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2.2.3.8 O09CC-1 Optical Coupler Card

The O09CC-1 is a bidirectional card which implements a Bidirectional Splitter-Combiner for Colorless Add/Drop.

The multiplexer part is equipped with a 9:1 combiner. All inputs includes a monitor diode for LOS detection and signaling to laser safety bus and to Fault-Management.

Demultiplexer part is equipped with a 1:9 splitter. Common input includes a monitor diode for LOS detection and signaling to laser safety bus and to Fault-Management.

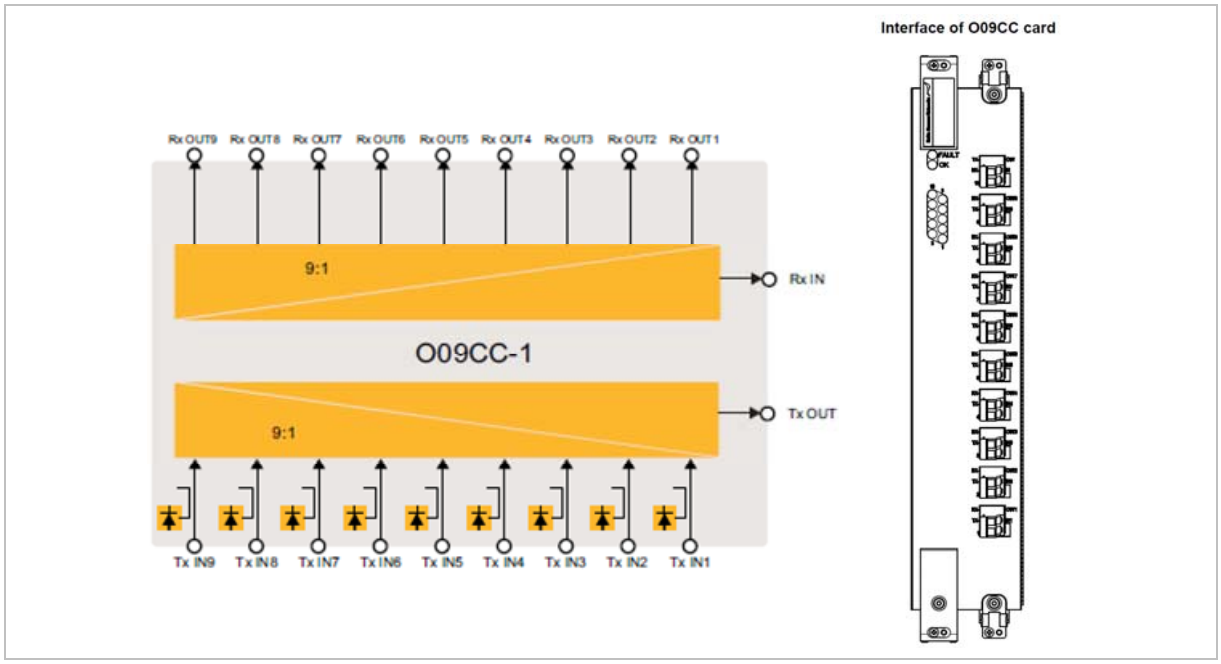

Fig. 36 O09CC-1 card structure

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2.2.3.9 F80DCI Drop Splitter and Interleaver Card

The F80DCI cards is used in 80-channel ROADM NE's for demultiplexing of an 80-channel DWDM signal with 50 GHz spacing by de-interleaving into the corresponding 40-channel standard and offset frequency groups of 100 GHz spacing each.

The F80DCI card contains one optical 50GHz/100GHz interleaver filters, one LOS monitor for the received 80-channel line signal, and power level monitors for the outgoing 40-channel signals are used for laser safety control.

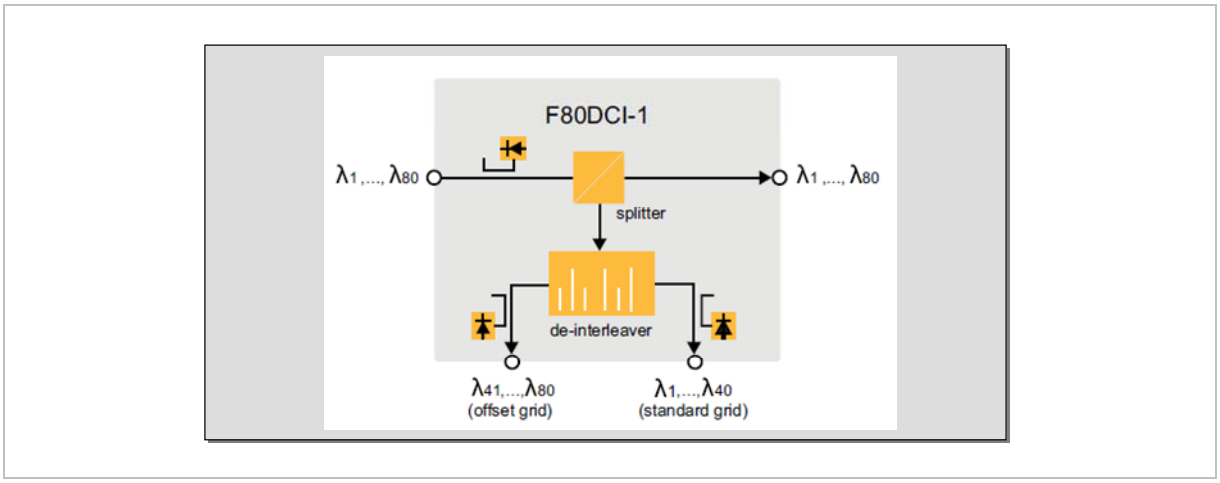

Fig. 37 F80DCI-1 card structure

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2.2.3.10 F80MDI Interleaver Card

The F80MDI cards is used in 80-channel Terminal and OADM NE's for multiplexing/demultiplexing of an 80-channel DWDM signal with 50 GHz spacing by interleaving/de-interleaving the corresponding 40-channel standard and offset frequency groups of 100 GHz spacing each.

The F80MDI card contains 2 optical 50GHz/100GHz interleaver filters, power level monitors for outgoing 40-channel signals are used for laser safety control. An auxiliary optical input is provided for later access to auxiliary laser light for transient suppression (future release) in combination with a monitor port for the 80-channel output signal.

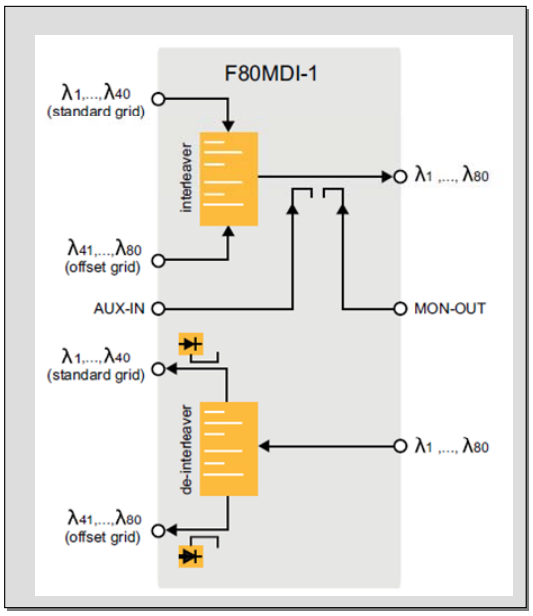

Fig. 38 F80MDI-1 card structure

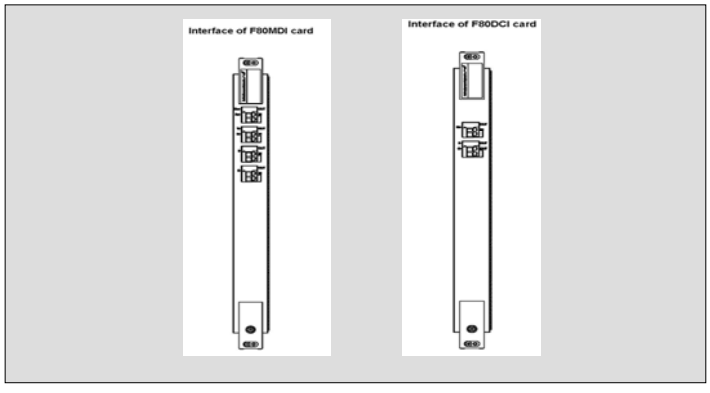

Fig. 39 HW layout

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2.2.4 Applications of Wavelength-Selective Switch Cards

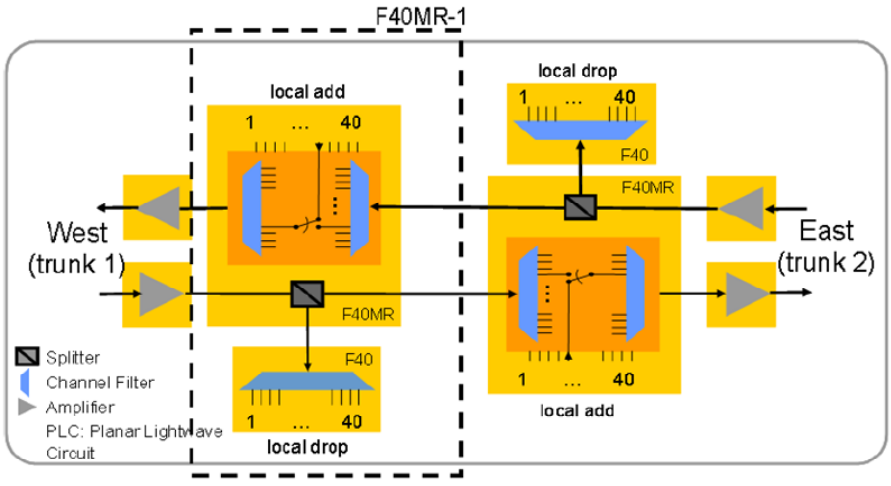
2.2.4.1 ONN-R with F40MR-1 - Wavelength-Selective Switch (WSS) Card

The F40MR card includes an integrated Planar Lightwave Circuit based wavelength selective switch (PLC-WSS) with low insertion loss, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength.

The output DWDM signal towards the line interface (booster or booster-less interface) of the PLC-WSS is a DWDM signal resulting from multiplexing 40 optical channels which are individually selectable (via SW control) between the 40 incoming pass-through channels and the 40 local add channels. For each optical channel to be transmitted a VOA function and an optical power monitor diode are available. The input DWDM signal from the line interface (optical pre-amplifier) is optically splitted into pass-through traffic and local drop traffic, where the pass-through direction also provides an optical input power monitor for detection of loss-of-signal and laser safety control. The pass-through traffic ports are connected to the pass-through traffic ports of the F40MR card for the corresponding opposite line direction, thereby achieving East/West Reparability between the respective DWDM line directions.

The F40MR-1 card provides 45 front connectors within 23 duplex LC/PC connectors on the front panel for access to all optical ports, it occupies 3 slots (3x 30mm).

ROADM architecture for 40 channels, ONN-R



- Nodal degree 1..5, in-service upgrade from terminal to ROADM
- Alternatively: F02MR based on WSS technology can be used channel power monitors, and local add filters
- support of patch through on drop side to ROADM node in 2nd ring (ring interconnect)

Fig. 40 F40MR-1 - Wavelength-Selective Switch (WSS) Card

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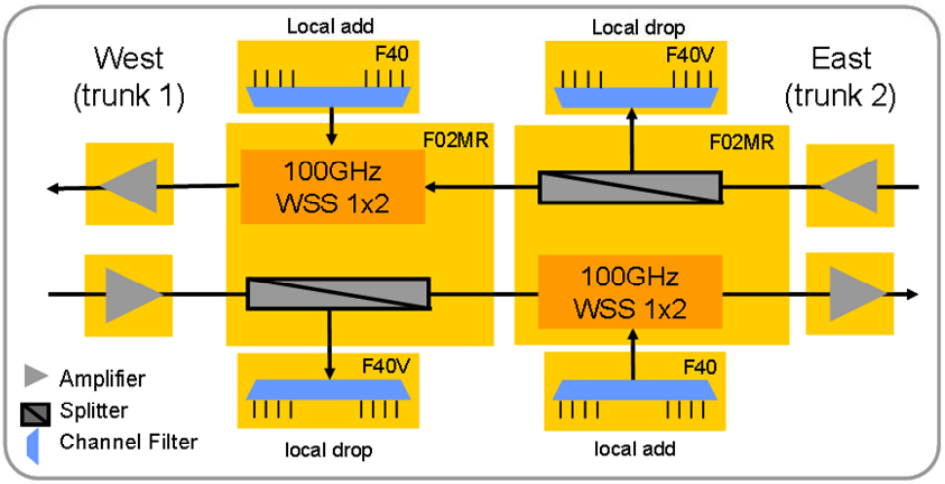
2.2.4.2 ONN-R2 with F02MR-1 - Wavelength-Selective Switch (WSS) Card

The F02MR is a cost optimized alternative to the F40MR card. It includes an integrated MEMS WSS based wavelength selective switch (MEMS-WSS) with low insertion loss, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength.

In the Tx path, the key component of this card is the integrated MEMS based 2:1 wavelength selective switch (MEMS-WSS) module, providing a remotely (via NMS) reconfigurable optical switching function per individual wavelength. The incoming signals of the cross-connect are switched with the WSS module on the common output which is followed by a booster amplifier. One of the inputs of the WSS is connected to the output of a mux filter where the local add channels are inserted.

In the RX path, the incoming signal from the pre-amplifier is launched into a 1x2 splitter with a 40/60 splitting ratio. At the higher output port, a demux filter (F40/S) can be connected for local drop traffic. The other port is the output of the cross-connect. At both inputs of the WSS and the C-COM port of the splitter, LOS monitors are used for supervision. Also a power monitor is present at the splitter drop output.

ROADM architecture for 40 channels, ONN-R2



- Nodal degree 1..2, in-service upgrade from terminal to ROADM
- Alternatively: F40MR based on PLC technology can be used with integrated VOAs, channel power monitors, and local add filters
- East-west separation per design
- support of patch through on drop side to ROADM node in 2nd ring (ring interconnect)

For internal use

Fig. 41 F02MR-1 - Wavelength-Selective Switch (WSS) Card

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2.2.4.3 ONN-X with F08MR card 40-Channel Multi-Degree Wavelength-Selective Switch (MEMS-WSS)

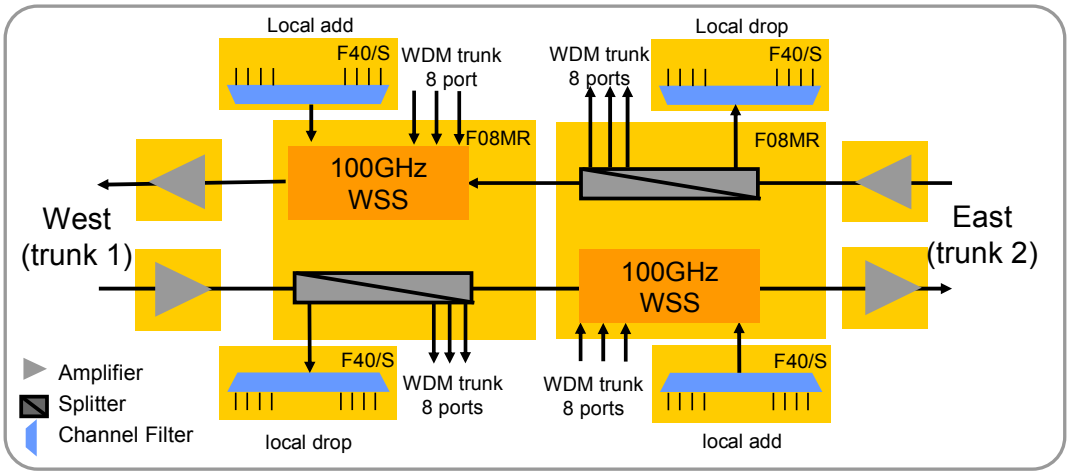
The F08MR card which includes an integrated MEMS based 8:1 wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength.

The input DWDM signal from a line interface (optical pre-amplifier) is optically splitted into 7 cross-connect outputs and 1 local drop traffic output, where the drop output also provides an optical input power monitor for detection of loss-of-signal and laser safety control. The WSS module collects DWDM traffic from 7 other line ports and 1 local add traffic input and performs arbitrary pass-through switching for any wavelengths from any input of its 8 input ports towards its output port.

The internal cross-connect traffic ports from different F08MR cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions.

The MEMS-WSS unit supports hitless wavelength switching for any unchanged optical channel interconnections.

Photonic Cross Connect (PXC) for 40 channels



- PXC, supporting nodal degree 8
- one WSS for channels add and one splitter for channel drop per nodal degree
- fully remotely configurable
- east-west separation
- (only two degree shown in figure)

For internal use

Fig. 42 F08MR-1 - Wavelength-Selective Switch (WSS) Card

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2.2.4.4 ONN-RT - The 8 or 16-Channel Metro Tunable ROADM with Multi-Degree Wavelength-Selective Switch (MEMS-WSS)

The F09MDRT-1/x is a bidirectional tunable WSS card. Each of the drop channels of the WSS is tunable and remotely configurable. I contains a 9x1 WSS with 100GHz spacing and a 9x1 coupler structure. In order to support 80 channel operation with 50GHz spacing, two cards are required with a /S and /O variant of the WSS card.

These two cards are operated in parallel using an interleaver and this combination supports a total of 2x8 channels of tunable add/drop.

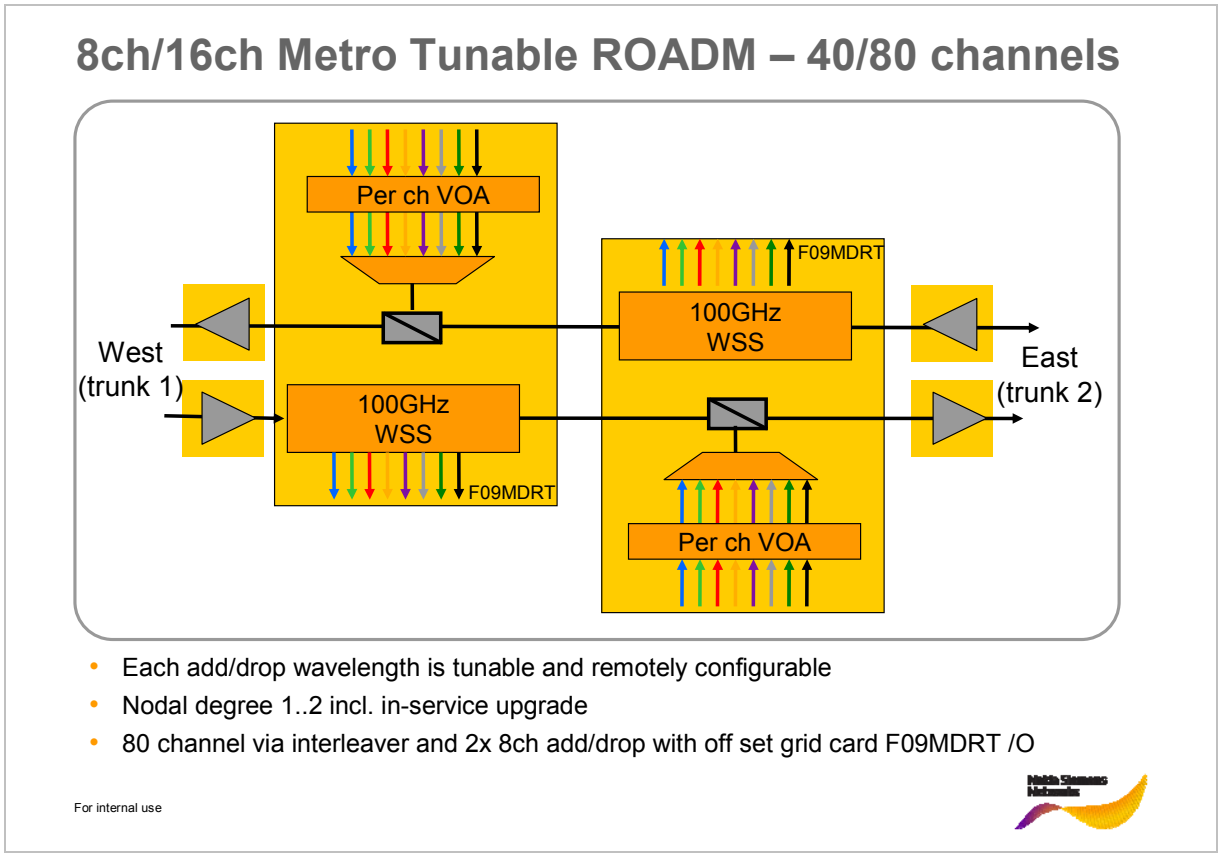
8ch/16ch Metro Tunable ROADM – 40/80 channels
Per ch VOA
100GHz WSS
F09MDRT
West (trunk 1)
East (trunk 2)
100GHz WSS
F09MDRT
Per ch VOA
Each add/drop wavelength is tunable and remotely configurable
Nodal degree 1..2 incl. in-service upgrade
80 channel via interleaver and 2x 8ch add/drop with off set grid card F09MDRT /O
For internal use

Fig. 43 F09MDRT-1 - Wavelength-Selective Switch (WSS) Card used as ONN-RT

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2.2.4.5 ONN-X with F0xDR80 and the F0xMR80 cards (80-Channel Multi-Degree Wavelength-Selective Switch (MEMS-WSS))

The F0xDR80 and the F0xMR80 cards each including an integrated MEMS based 1:6 (6:1) or 1:9 (9:1) wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength.

The input DWDM signal from a line interface (optical pre-amplifier) is switched per wavelength by the MEMS-WSS unit on the F0xDR80 card, either to any of cross-connect output ports or to one of the two local drop traffic ports, which are already divided into two 40-channel frequency groups of standard grid and offset grid, respectively, so that no further interleaver is needed. A LOS monitor for the input signal is provided for laser safety control at the line interface and each output port is also supervised for overpower detection to ensure laser safety of hazard level 1M.

The output DWDM signal to a line interface (optical booster) is created by the MEMS-WSS unit on the F0xMR80 card, which switches per wavelength from any of the cross-connect input signals or from one of the two local add traffic ports, which are already divided (by the feeding multiplexer cards, not shown in Figure) into two 40-channel frequency groups of standard grid and offset grid.

The internal cross-connect traffic ports from F0xDR80 and F0xMR80 cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions.

The MEMS-WSS units support hitless wavelength switching for any unchanged optical channel interconnections.

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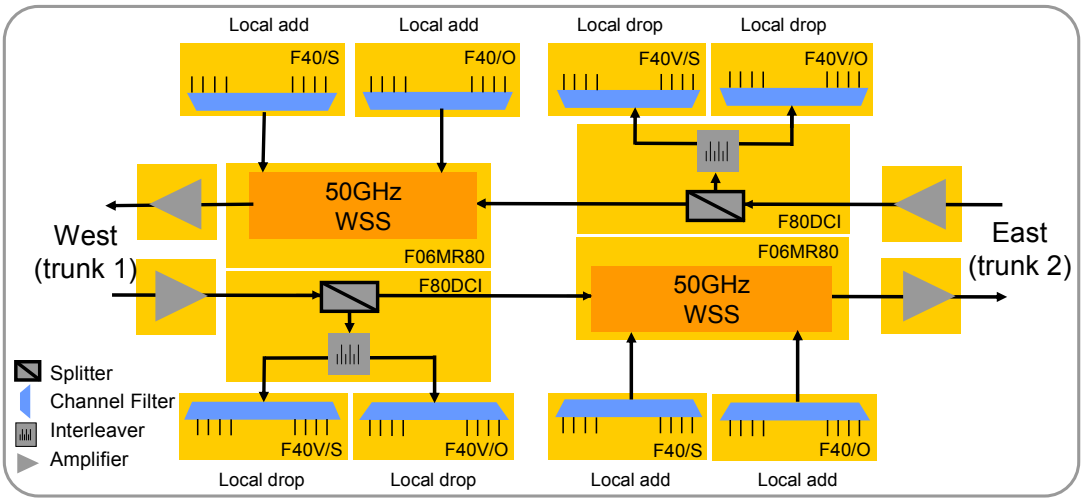
Remotely configurable ROADM – 80 channels

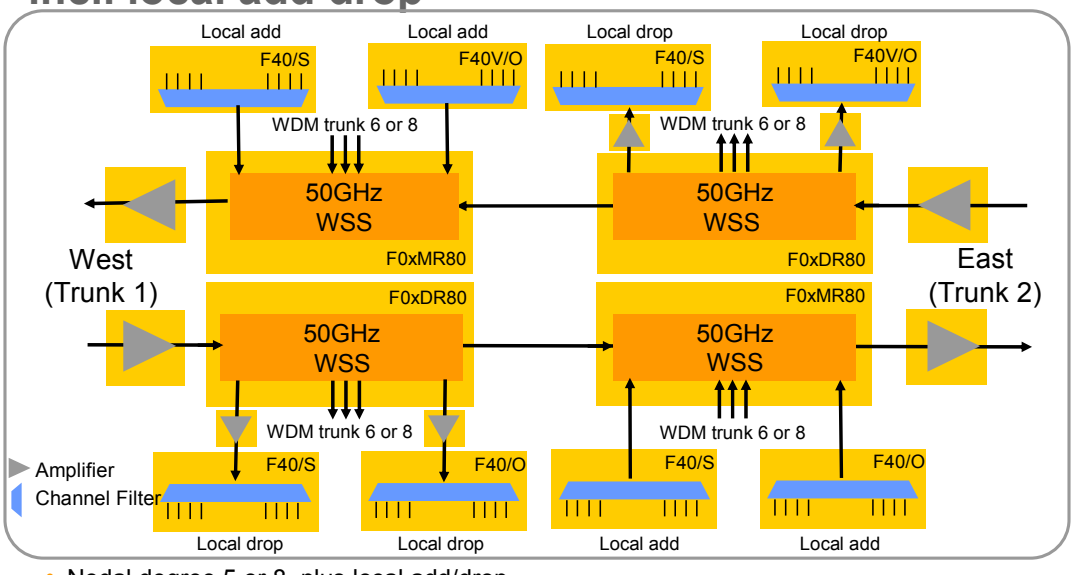


- Nodal degree 2, in-service upgrade from terminal to ROADM
- Power monitoring per channel via one MCP card
- East-west separation per design

For internal use

Fig. 44 F06MR80-1 - Wavelength-Selective Switch (WSS) Card used as ONN-R80

PXC with double WSS structure for 80 channels incl. local add drop



- Nodal degree 5 or 8, plus local add/drop
- Drop amplifiers (type LAS) for increased power budget and reach
- (only two directions shown in figure)

For internal use

Fig. 45 F0xMR80-1 and F0xDR80-1 - Wavelength-Selective Switch (WSS) Card

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2.2.4.6 ONN-X96 with F09MDR96-1 cards (MEMS-WSS))

The F09MDR96-1 card include an integrated MEMS based 1:9 (9:1) wavelength selective switch (MEMS-WSS) module, providing a remotely (via SW) reconfigurable optical switching function per individual wavelength.

The input DWDM signal from a line interface (optical pre-amplifier) is switched per wavelength by the MEMS-WSS unit on the F09MDR96-1 card, either to any of cross-connect output ports or to one of the two local drop traffic ports, which are already divided into two 48-channel frequency groups of standard grid and offset grid, respectively, so that no further interleaver is needed. A LOS monitor for the input signal is provided for laser safety control at the line interface and each output port is also supervised for overpower detection to ensure laser safety of hazard level 1M.

The output DWDM signal to a line interface (optical booster) is created by the MEMS-WSS unit on the F09MDR96-1 card, which switches per wavelength from any of the cross-connect input signals or from one of the two local add traffic ports, which are already divided (by the feeding multiplexer cards, not shown in Figure) into two 48-channel frequency groups of standard grid and offset grid.

The internal cross-connect traffic ports from F09MDR96-1 cards (of different line directions) can be optically interconnected to allow for configurable pass-through traffic between arbitrary line directions.

The MEMS-WSS units support hitless wavelength switching for any unchanged optical channel interconnections.

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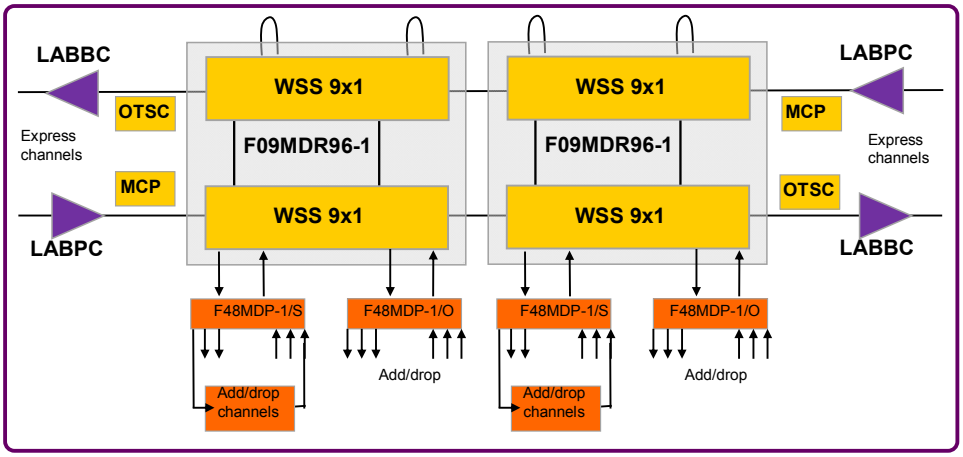
Photonic cross connect PXC – 96 channels



- Nodal degree 1 up to 8, in-service upgrade from terminal to PXC
- Power monitoring per channel MCP card
- East-west separation per design

For internal use

Fig. 46 F09MDR96-1 - Wavelength-Selective Switch (WSS) Card used as ONN-X96

Directionless and colorless PXC – ONN-X96

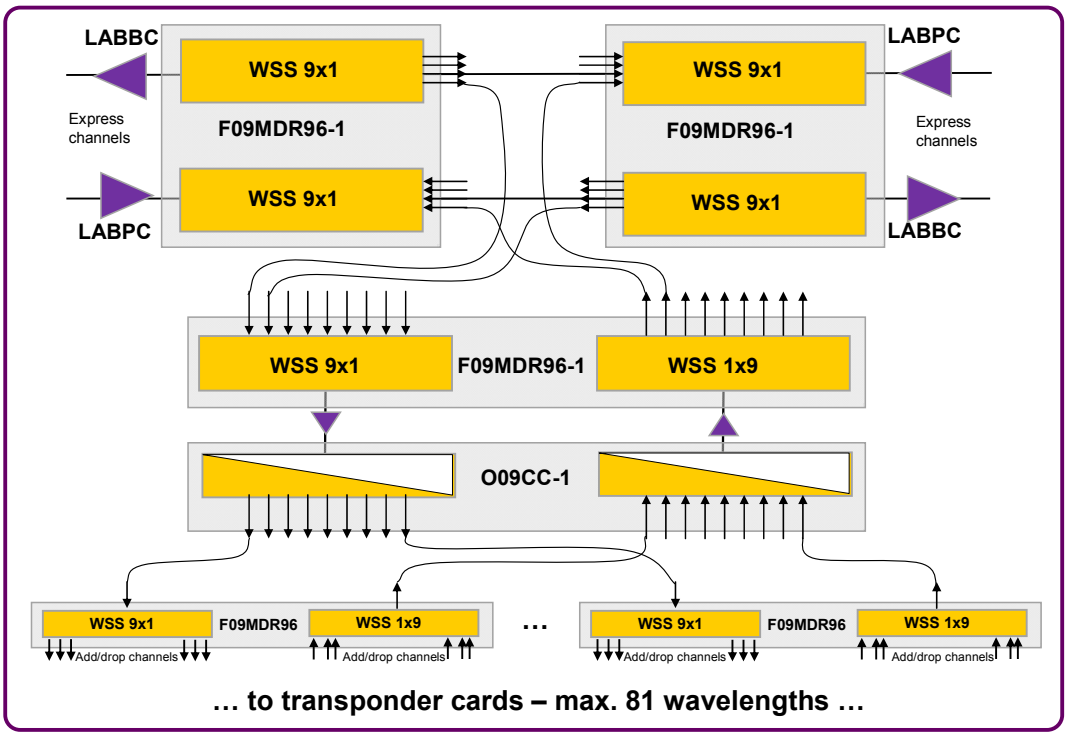


Fig. 47 F09MDR96-1 - Directionless and colorless PXC for 96 channels

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2.3 Amplification scheme

2.3.1 EDFA amplifiers

The Line Amplifier (LA) cards provide the signal amplification by featuring a gain block with one or two pump lasers, inter-stage access for dispersion compensation, and digital gain control.

SURPASS hiT7300 offers various types of amplifier cards well suited for various network scenarios, depending on the required performance of the span. The amplifier design is multi-stage and modular. This allows for “application optimized” solutions and “cost optimized” choice of amplifiers. The modular amplifier design ensures the lowest possible CAPEX investment for each supported network scenario.

LA cards are divided in three types of amplification (inline, booster and preamplifier):

- Inline amplifiers contain an optical inline amplifier for C band and are used at inline sites for optical amplification of the signal. The output power of the cards can be increased by pump cards and Raman pump cards.
- Booster amplifiers contain an optical booster amplifier for C band and are used at terminal sites for amplifying the outgoing line signal. In one link direction, there is only one booster. The output power of these cards can be increased by pump cards.
- Pre-amplifiers contain an optical preamplifier for C band and are used at terminal sites for amplifying the incoming line signal before it is fed into the demultiplexing stage. In one link direction, there is only one preamplifier. The output power of the cards can be increased by pump cards and Raman pump cards.

Additionally, the various types of amplifiers can be categorized into 3 generic types:

- Line Amplifier Short Span (LASx)
- Line Amplifier Medium Span (LAMx)
- Line Amplifier Long Span (LALx)
- Line Amplifier Very Long Span (LAVx)
- Line Amplifier Broadband for 96 channels (LABx)

TIP
All the amplifier cards also have internal bus connection for EOW, user channel access and APSD control functions.

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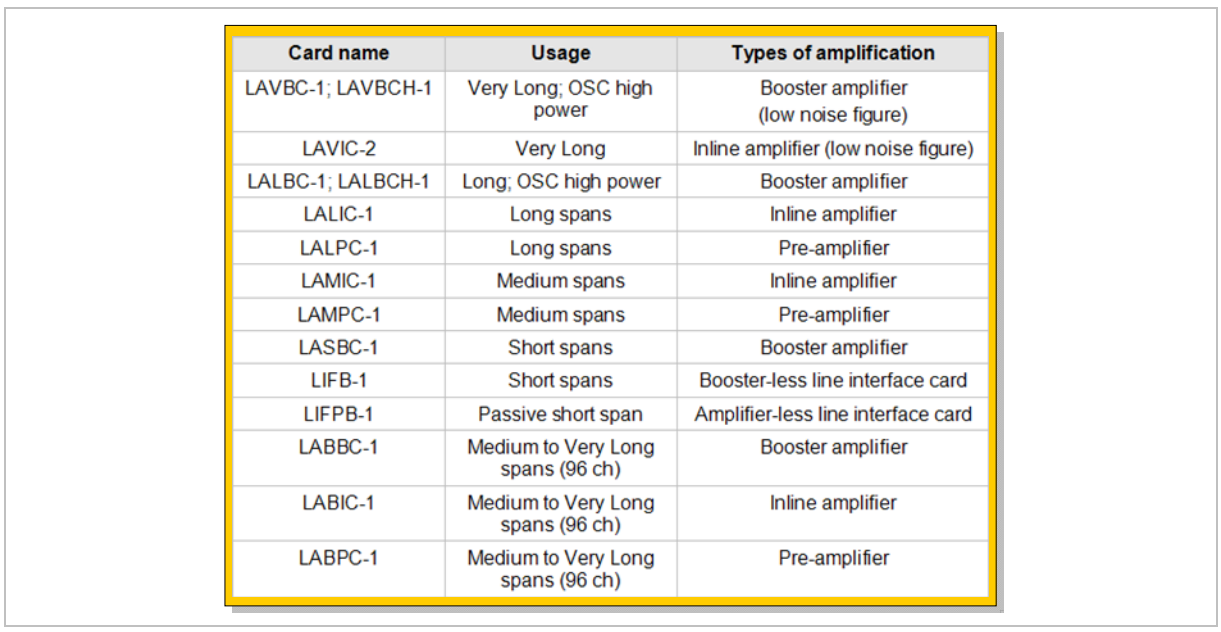
The following table lists all the SURPASS hiT7300 EDFA Amplifier cards:

Card name	Usage	Types of amplification
LAVBC-1; LAVBCH-1	Very Long; OSC high power	Booster amplifier (low noise figure)
LAVIC-2	Very Long	Inline amplifier (low noise figure)
LALBC-1; LALBCH-1	Long; OSC high power	Booster amplifier
LALIC-1	Long spans	Inline amplifier
LALPC-1	Long spans	Pre-amplifier
LAMIC-1	Medium spans	Inline amplifier
LAMPC-1	Medium spans	Pre-amplifier
LASBC-1	Short spans	Booster amplifier
LIFB-1	Short spans	Booster-less line interface card
LIFPB-1	Passive short span	Amplifier-less line interface card
LABBC-1	Medium to Very Long spans (96 ch)	Booster amplifier
LABIC-1	Medium to Very Long spans (96 ch)	Inline amplifier
LABPC-1	Medium to Very Long spans (96 ch)	Pre-amplifier



Card name	Usage	Types of amplification
LAVBC-1; LAVBCH-1	Very Long; OSC high power	Booster amplifier (low noise figure)
LAVIC-2	Very Long	Inline amplifier (low noise figure)
LALBC-1; LALBCH-1	Long; OSC high power	Booster amplifier
LALIC-1	Long spans	Inline amplifier
LALPC-1	Long spans	Pre-amplifier
LAMIC-1	Medium spans	Inline amplifier
LAMPC-1	Medium spans	Pre-amplifier
LASBC-1	Short spans	Booster amplifier
LIFB-1	Short spans	Booster-less line interface card
LIFPB-1	Passive short span	Amplifier-less line interface card
LABBC-1	Medium to Very Long spans (96 ch)	Booster amplifier
LABIC-1	Medium to Very Long spans (96 ch)	Inline amplifier
LABPC-1	Medium to Very Long spans (96 ch)	Pre-amplifier

Fig. 48 EDFA amplifiers

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2.3.1.1 Line Amplifier for Short Span (LASBC)

The LASBC amplifier is an EDFA dual-stage amplifier card designed for short span applications without Interstage access. LASBC can be used as a booster amplifier in all ONN node types. The EDFA “Stage 1” is optimized for amplification of a low power signal and therefore for low noise amplification. With a Gain Flattening Filter (GFF) and an automatically controlled Variable Optical Attenuator (VOA) between EDFA stages 1 and 2, the excellent gain flatness is achieved over a wide range of gain settings.

An external monitor interface for connection to an Optical Spectrum Analyzer or the optical channel power monitor card is also available for external signal monitoring functions. The amplifier also has internal signal monitoring functions on the board. The OSC (Optical Supervisory Channel) termination is done locally on the card and control information is digitally forwarded into the main controller.

The EDFA “Stage 2” does the final amplification of the DWDM signal before it re-enters the fiber, allowing for maximum reach.

2.3.1.2 Line Amplifiers for Medium Span (LAMPC, LAMIC)

The LAMPC and LAMIC cards are dual-stage EDFA amplifier cards for medium span applications and provide an additional “Interstage” access port for dispersion compensation. The LAMPC can be used as a preamplifier card in all the ONN node types, and the LAMIC card can be used as an in-line amplifier card in the OLR nodes.

The interstage access points between each EDFA section allow for the addition of inline optical components to enhance the performance of the amplification process as well as the overall network performance. The interstage port can be optionally interconnected with either a Dispersion Compensation Fiber (DCF) or a Fiber Bragg Grating (FBG) card depending on type of fiber choice and dispersion compensation requirement of the network.

The EDFA “Stage 1” together with the Variable Optical Attenuator (VOA) provides moderate optical amplification so that the output signal level is appropriate for interconnection to a dispersion-compensating device interconnected at the interstage access port.

All the attenuation incurred by any interstage optical device is already calculated in the optical link budget and the “Stage 2” EDFA provides optimum amplification for the following span.

All other functions such as OSC extraction and insertion, internal and external signal monitoring and gain flattening filter are also available.

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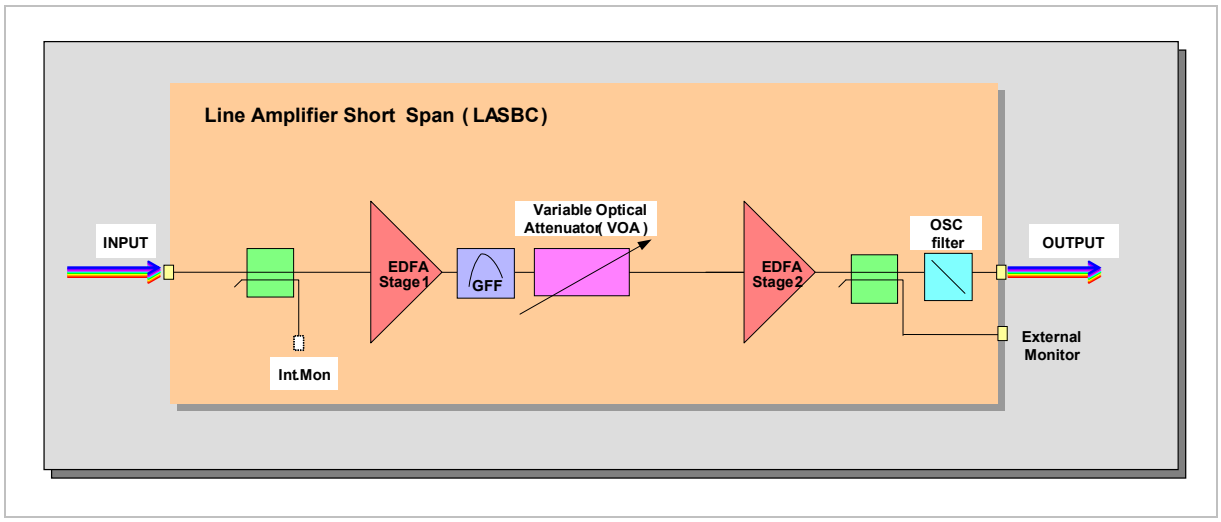

Fig. 49 Line Amplifier for Short Span (LASBC)

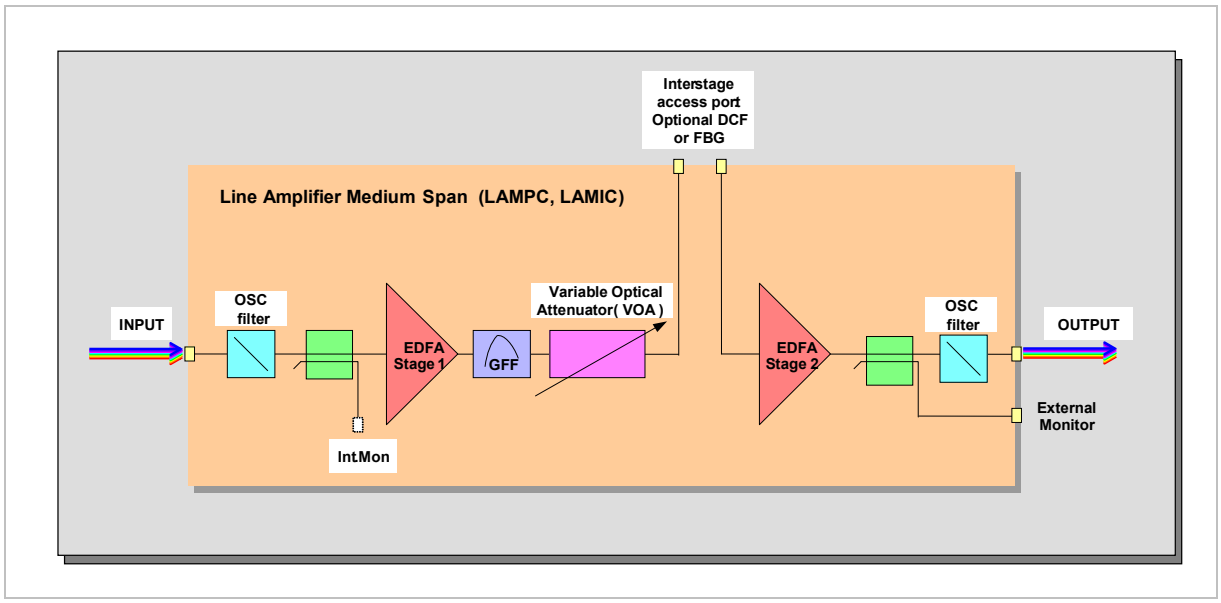

Fig. 50 Line Amplifiers for Medium Span (LAMPC, LAMIC)

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2.3.1.3 Line Amplifiers Long and Very Long Span (LALBC, LALBCH, LALIC, LALPC , LAVBC and LAVIC)

The LALBC/LALIC/LALPC amplifier cards provide three-stage EDFA amplification for long span applications. The LALBC can be used as booster amplifier card, and the LALPC can be used as preamplifier card in all ONN node types, whereas the LALIC can be used as in-line amplifier in OLR nodes.

All LALxC cards provide all the features provided by LASBC and LAMxC cards and further provide “Stage 3” amplification with optional access to an external PUMP card for extra amplification in applications with very long spans and/or high number of optical channels.

The LALxC cards can also compensate for higher attenuation at their interstage access port, which is useful for cascading of dispersion compensation cards.

TIP
The difference between LALBC and LALBCH is that LALBCH contains a high power OSC laser which provides for a maximum span loss of 50 dB at 1510nm OSC wavelength (corresponding to about 48.5 dB span attenuation of G.652 fiber within C-band).

The LAVBC and LAVIC amplifier cards are similar to the LALxC cards, but generate just a low noise figure.

2.3.1.4 Line Amplifiers for 96 channel system (LABBC, LABIC and LABPC)

The LABBC/LABIC/LABPC amplifier cards provide three-stage EDFA amplification for medium to very long span applications. The LABBC can be used as booster amplifier card, and the LABPC can be used as preamplifier card in all network elements supporting the 96 channel structure, whereas the LABIC can be used as in-line amplifier in OLR nodes.

TIP
The LABxC amplifier do not support DCM modules. They where designed for the DCM free transmission and have due to this no interstage access.

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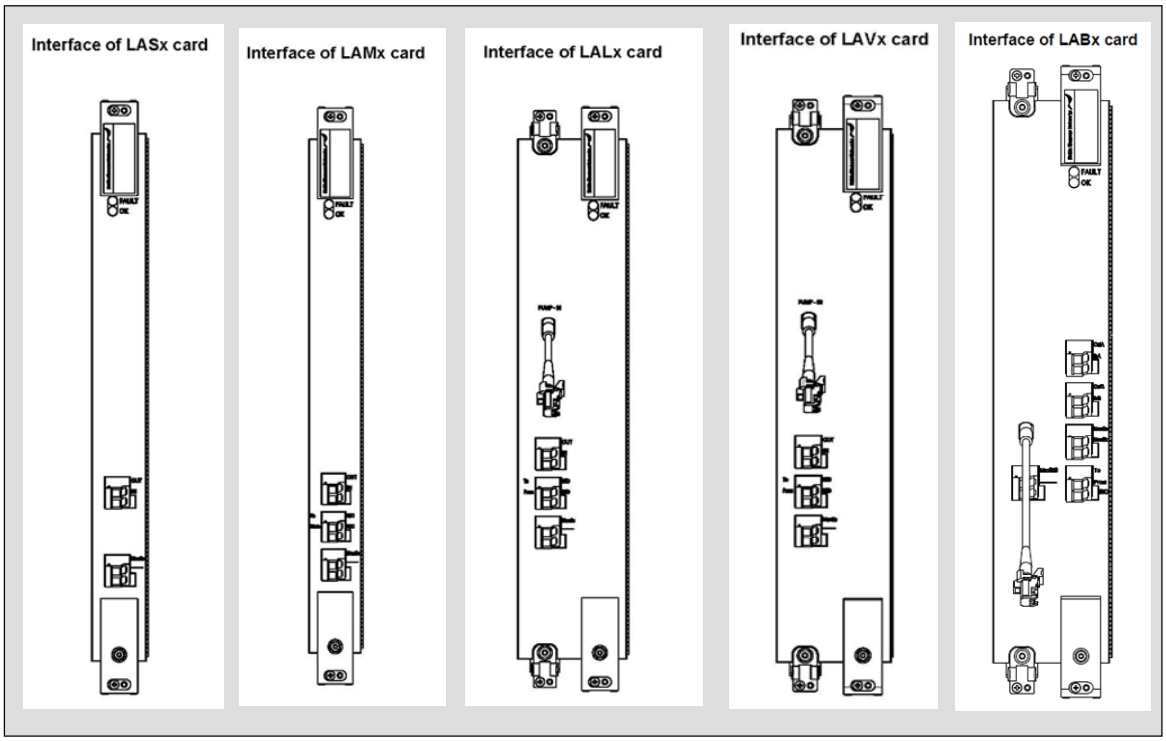

Fig. 51 HW layout amplifier

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2.3.1.5 Optical Amplifier Features

Optimum Amplifier Gain Setting and Fast Gain Control:

Each hiT7300 amplifier is designed to have the optimum gain flatness over the entire wavelength spectrum for a particular value of total amplifier gain. In order to keep the EDFA's operating at a particular optimum gain, while allowing for a wide range of span losses, an automatically controlled VOA is used between the first and second stage of the amplifier.

A fast control loop (analogue and/or digital) is implemented to keep the gain value constant within the allowed range of overall system transient behavior. This ensures that even abrupt changes in the input signal power, such as those caused by channel losses, will not cause excessive bit errors or degradations in the individual channels.

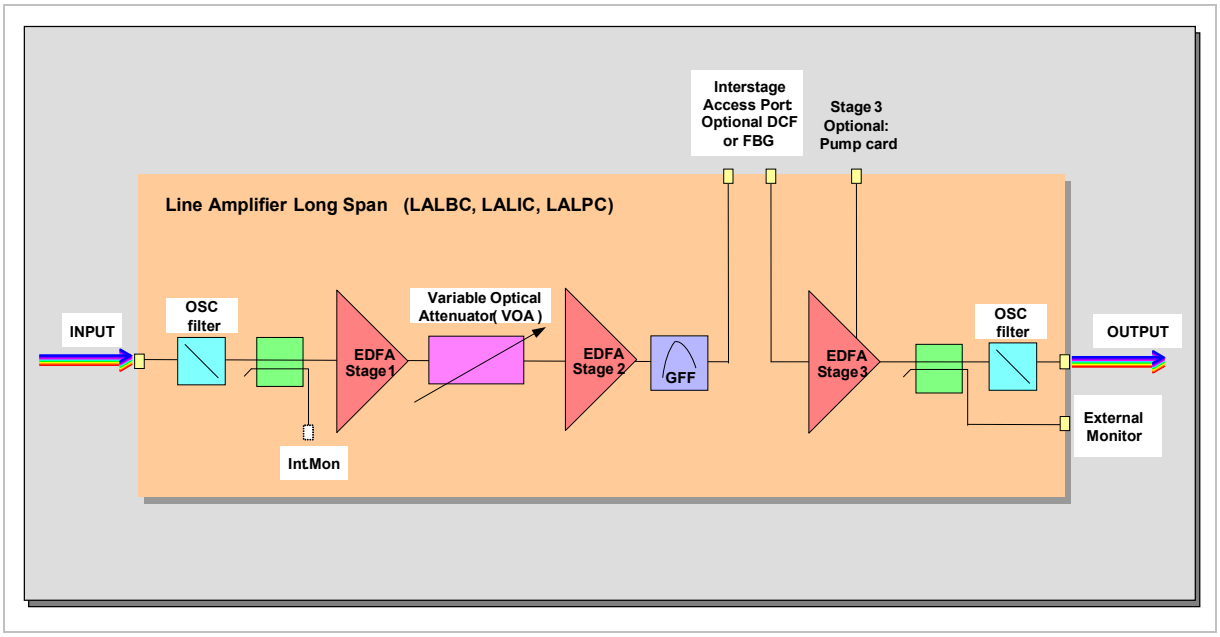

Fig. 52 Line Amplifiers Long Span (LALBC, LALIC, LALPC)

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Amplifier Output Power Control:

Based on the number of channels equipped in the DWDM system and the required EDFA output power per channel, the total output power of an EDFA can be determined. This total EDFA output power is kept constant via a slow output power control loop, to compensate for degradations or fluctuations in the fiber attenuation. Hence, the typical physical changes in fiber properties (e.g. due to aging) will have no influence on ongoing system performance.

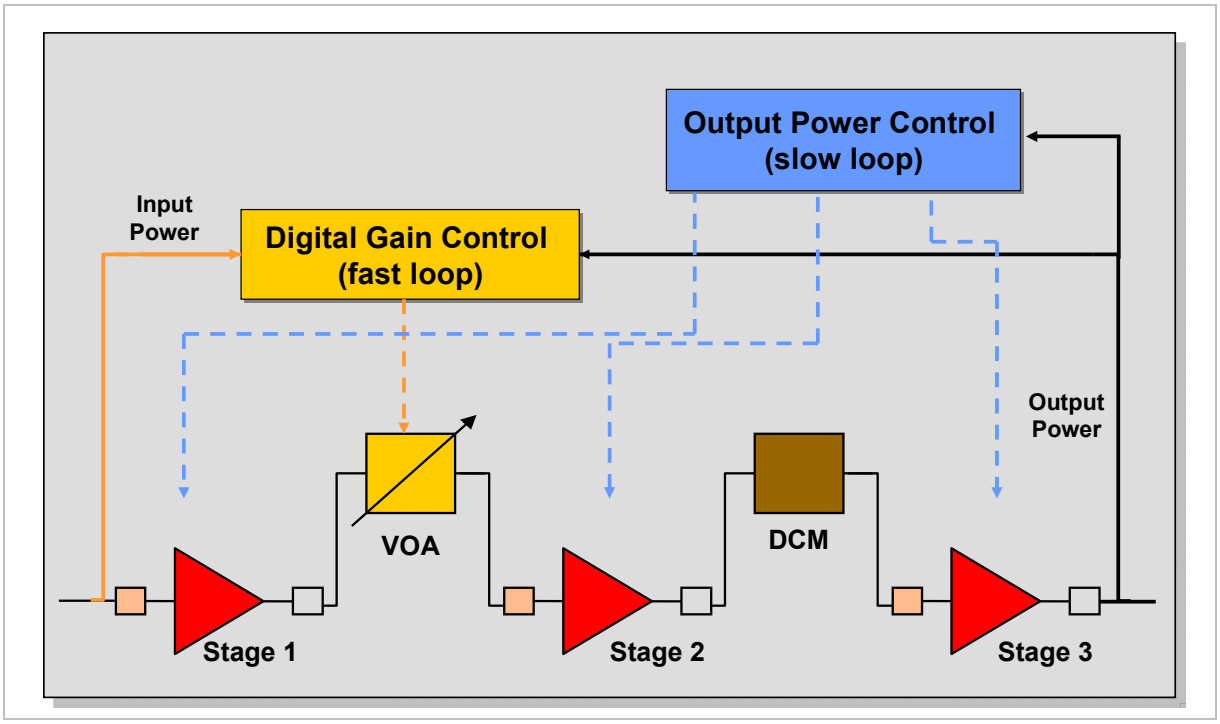

Fig. 53 Optical Amplifier Features

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2.3.2 Amplifier-less Line Interfaces (LIFB / LIFPB)

LIFB-1 card is a unidirectional booster-less line interface card for the transmit direction of a DWDM line interface; this card can replace a booster amplifier card (LASB) for short span applications.

LIFPB-1 card is a bidirectional amplifier-less line interface card for a DWDM line interface, this card can replace booster and pre-amplifier cards (LASB, LAMP) for passive short span applications.

The LIFB-1/LIFPB-1 cards provide the following functions:

- OSC termination (LIFB: only for Tx direction; LIFPB: for both Tx/Rx directions), in order to support all OSC functions (optical link control, EOW, user channels, etc.) as usual amplifier cards.
- Optical output monitor connector(s) for optical channel power monitoring either by an external optical spectrum analyzer (OSA) or the MCP4xx monitoring card (LIFB: only for Tx direction; LIFPB: for both Tx/Rx directions).

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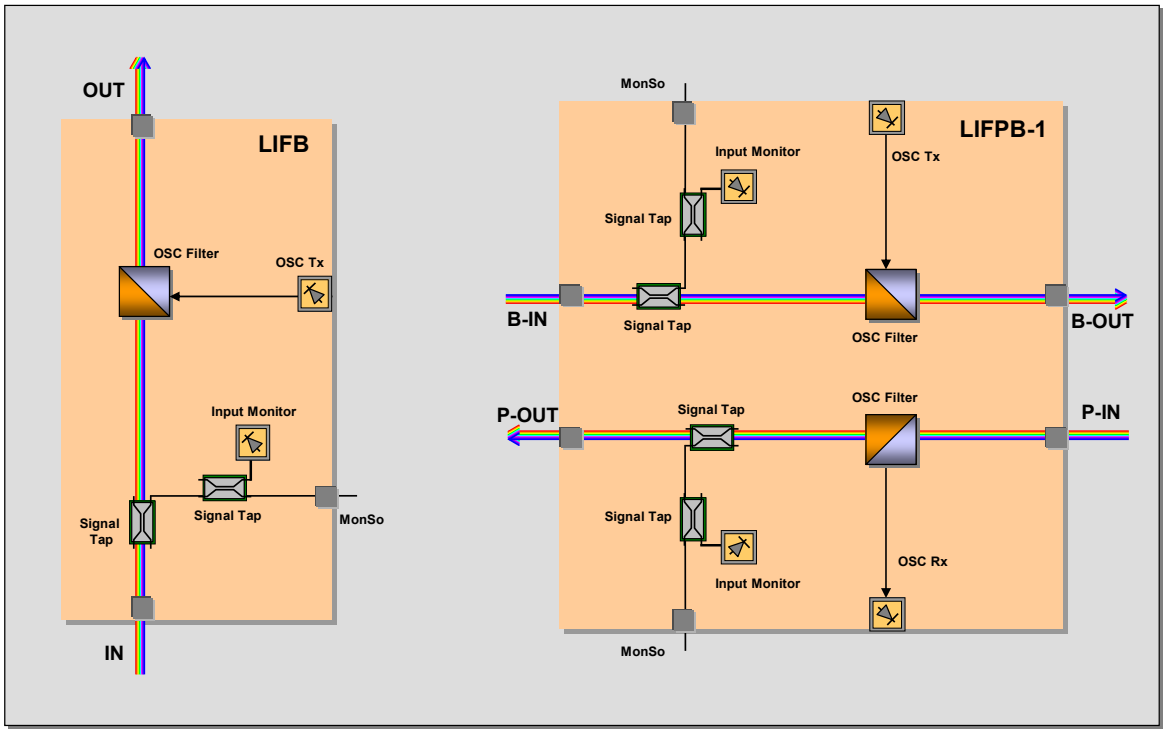

Fig. 54 Amplifier-less Line Interface (LIFB and LIFPB)

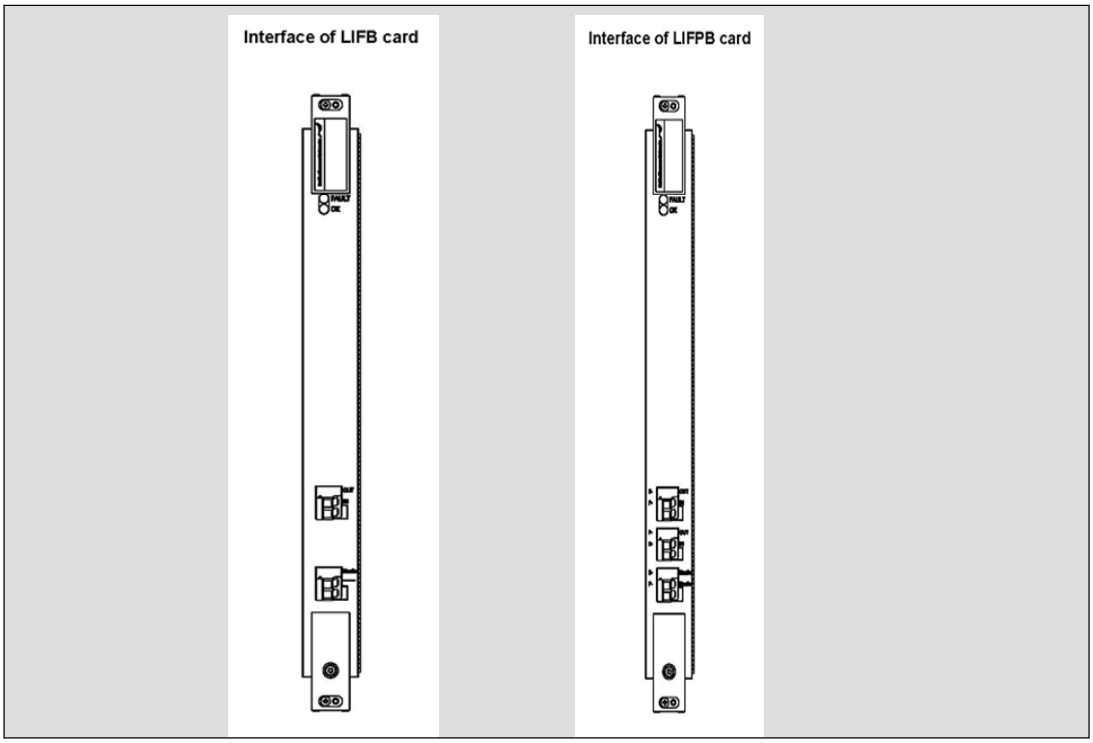

Fig. 55 HW layout

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2.3.3 Amplifier Pump Cards

To account for the variable optical conditions in backbone networks, such as different span lengths, fiber types and fiber properties, SURPASS hiT7300 has developed an external amplifier pump implementation. By equipping the external pump card PL-1 in combination with the LALx amplifier cards, a higher output power of these amplifiers can be achieved. By equipping the Raman pump card PRC-1 in combination (counter-directional) with the LALPC-1 pre-amplifier card or LALIC-1 in-line amplifier card, a higher gain can be achieved for the respective span.

2.3.3.1 External PUMP Card (PL-1)

The external pump card (PL-1) is used to increase the output power of the preamplifier, booster amplifier and inline amplifiers on the various amplifier cards. The PL-1 is an active card, which means it is equipped with its own card controller. It also contains an on-board EEPROM to store card inventory data that can be requested by the network management system.

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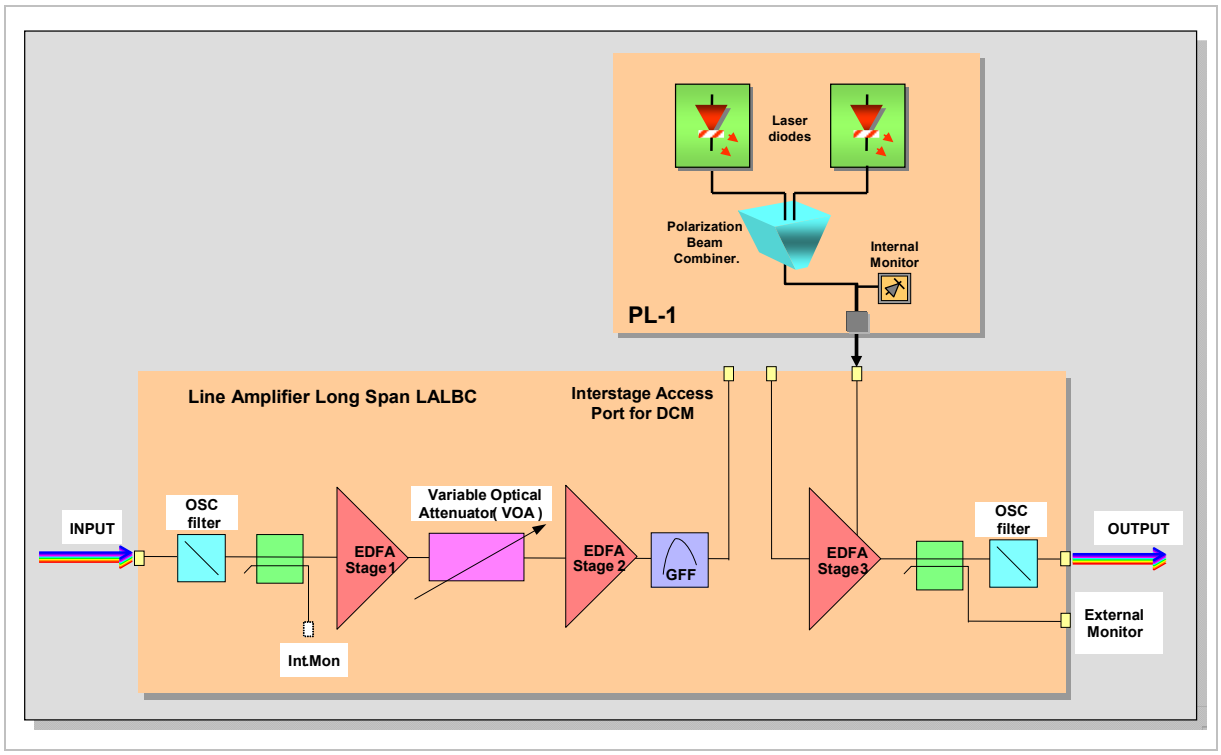

Fig. 56 External PUMP Card

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2.3.4 Raman amplification

To extend the distances between NE's (high loss spans) SURPASS hiT7300 optionally employs Raman amplification.

The basis of Raman amplification is the energy scattering effect called Stimulated Raman Scattering (SRS), a non-linear effect inherent to the fiber itself. SRS involves a transfer of power from an optical pump signal at a higher frequency (lower wavelength) to one at a lower frequency (higher wavelength), due to inelastic collisions in the fiber medium. If on optical pump wavelength is launched backwards into the end of a transmission fiber it propagates upstream in the opposite direction of the optical traffic wavelength, this is called counterdirectional pumping. The pump wavelength induces the SRS effect resulting in amplification of the optical traffic wavelength. With a sufficient amount of pump wavelength power the optical traffic wavelength slowly starts to deviate from the usual linear decrease, reaches a minimum level and finally increases when approaching the fiber end The distributed Raman amplification process results in an improvement of the OSNR budget by several dB thereby allowing networks with very long transmission span in combination with optical booster and preamplifiers.

2.3.4.1 Raman Pump Card (PRC-x)

The following picture shows the simplified internal architecture of the Raman pump card (PRC-x). The pump signals from the Laser diodes are first multiplexed from two different wavelengths, and the multiplexed pump light is counterdirectionally coupled into the fiber carrying the received traffic signal. By appropriate power settings for the two pump wavelengths, a flat gain spectrum can be achieved for different fiber types. The pump laser power is controlled via external monitor diodes and the output power is set by software. All pump lasers are also temperature controlled to maintain their stability. Two optical monitor ports are provided, one monitors the Raman output power and the other one monitors the line power.

The Raman PUMP card is utilized together with the LALPC or LALIC amplifier card to increase the possible length of a span.

TIP
The card PRC-1 is designed for the 40 and 80 channel system. The card PRC-2 is designed for the 96 channel system and has a broader channel spectrum which is amplified.

TIP
For Automatic Power Shut Down (APSD) an on board detection of the OSC carrier frequency is designed. The OSC signal is scrambled to have enough carrier signal power to provide APSD function.

Due to the laser pumps and the complexity of the card, the PRC-x occupies two 30 mm slots of the shelf.

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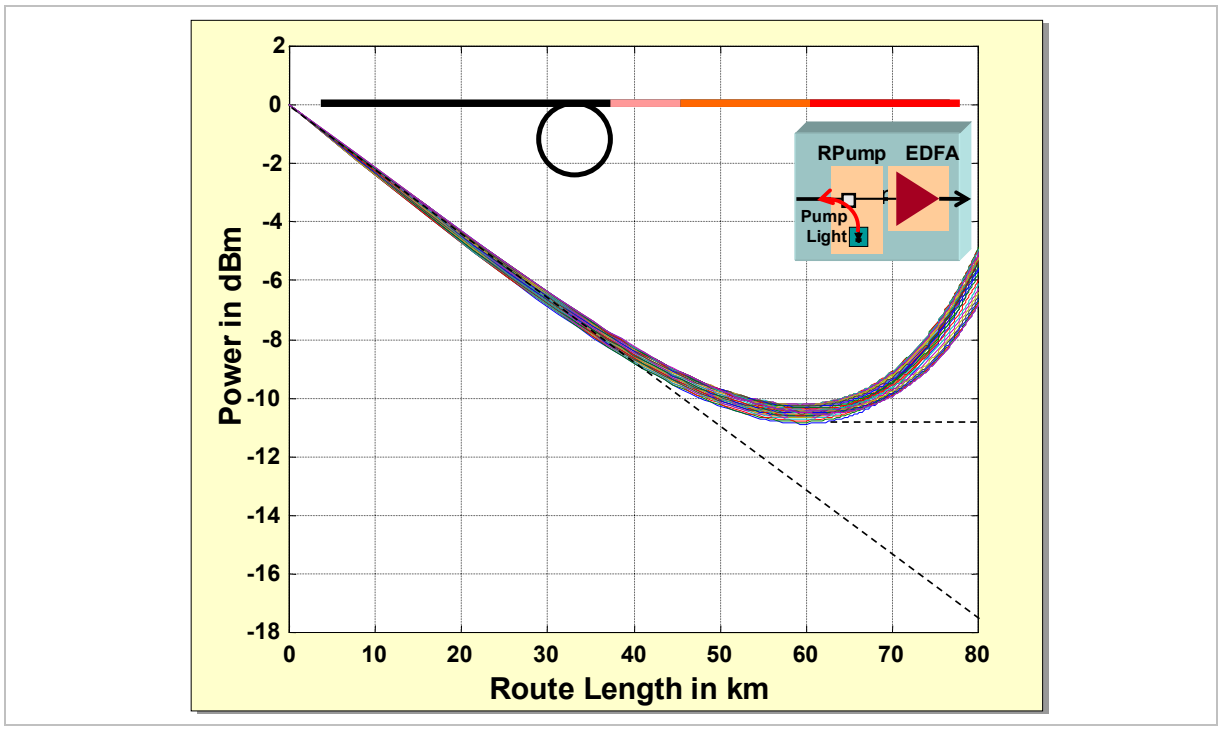

Fig. 57 Raman amplification

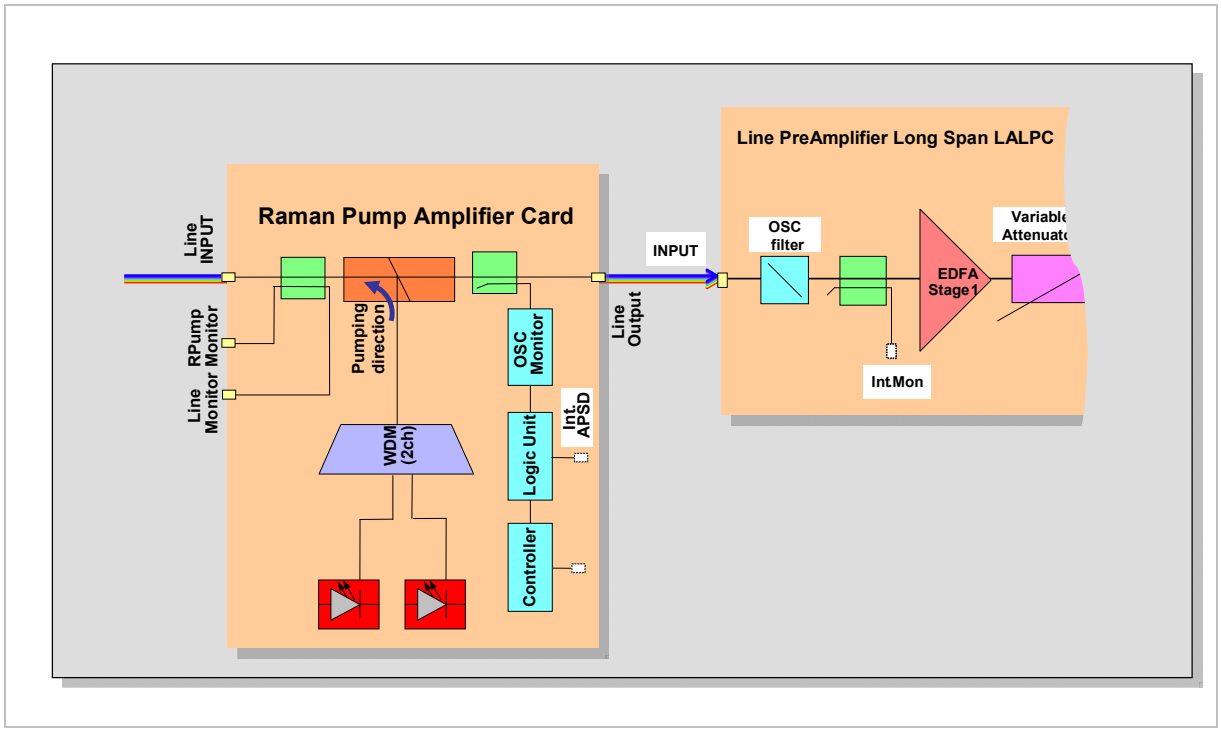

Fig. 58 Raman Pump Card (PRC-1)

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2.3.4.2 EDFA & Raman hybrid amplifier cards (LRBIC-1 / LRBPC-1)

To simplify network management, the Raman pump card (PRC-2) and either the line amplifier card (LABIC-1) or the pre-amplifier card (LABPC-1) can be logically combined into a single card cluster, which offers the following:

- Combined LRBxC-1 (LABxC and PRC-2 card) supporting all features from LABxC-1 and PRC-2
- Implementation of Raman padding or Raman pump power control by LABxC
- Cards have to be placed in adjacent slots (future plans to have LABxC controlled as single card by the management system)

TIP
For LRBIC-1 and LRBPC-1 cards technical specifications see the respective LABIC-1 and LABPC-1 cards and PRC-2 technical specifications.

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To simplify network management, the Raman pump card (PRC-2) and either the line amplifier card (LABIC-1) or the pre-amplifier card (LABPC-1) can be logically combined into a single card cluster , which offers the following:

- Combined LRBxC-1 (LABxC and PRC-2 card) supporting all features from LABxC-1 and PRC-2
- Implementation of Raman padding or Raman pump power control by LABxC
- Cards have to be placed in adjacent slots (future plans to have LABxC controlled as single card by the management system)

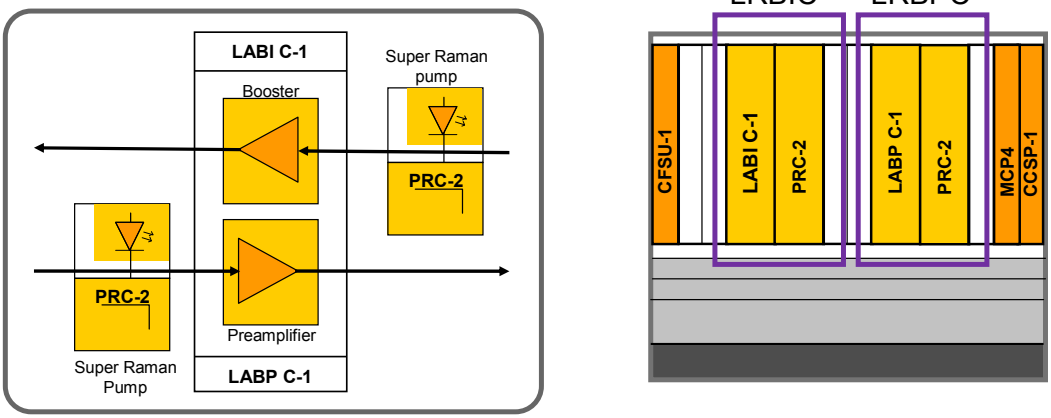

Fig. 59 Hybrid Amplifier Card (LRBxC-1)

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2.4 Dispersion compensation scheme

The chromatic dispersion has the effect of ‘spreading’ the signal spectrum so much that the inter-symbol interference no longer allows an accurate determination of a single ‘one’ bit or a single ‘zero’ bit. Dispersion compensation is used to counteract the chromatic dispersion which a signal undergoes as it travels through a section of optical fiber. Depending on the bit rate a system can tolerate a certain degree of dispersion; the rest has to be compensated for to avoid bit errors. This can be done in different ways, using pre- and post-compensation, so a kind of saw tooth profile results. The important fact is that the total allowable dispersion at the receive side is not exceeded.

2.4.1 Dispersion Compensation Cards

The DCM's (Dispersion Compensation modules) are utilizing either Fiber Bragg Gratings (FBG) or Dispersion Compensating Fiber (DCF). DCF is a spool of fiber with the opposite dispersion characteristics of the fiber used for signal transmission, hence ‘compressing’ the signal for better optical performance. FBG's are based on chirped fiber grating technology and offer smaller footprint, very low insertion loss, and lower nonlinear effects compared to DCF.

In hiT 7300 the DCM modules are in most cases integrated on DCM cards which are physically equipped in the hiT 7300 shelf as all other equipment and are managed by the NE controller. For special applications, where FBG-based DCMs are not available or cannot be used (e.g. for compensation of critical transmission lines with 40G channels or for 80-channel transmission lines), or for dispersion compensation of special fiber types, DCF-based external DCMs can be used which are mounted within a separate DCM shelf within the rack.

The front panel of a DCM cards contains two optical connectors, one input port of the DWDM signal before dispersion compensation and one for output port of the DWDM signal after dispersion compensation. The DCM input and output ports are connected to the interstage access port of an optical amplifier.

There are various DCM card types available for providing dispersion compensation of different lengths and types of transmission fibers. A certain DCM module on a DCM card is denoted by the card name.

TIP
The strategy for choosing DCM's is highly system dependent and is influenced by the optical performance limiting effect. The implementation of the DCM strategy and the correct calculation of the required residual dispersion is a feature of the network design tool SURPASS TransNet. Both DCM types can be combined to achieve the optimum network performance and the lowest system cost.

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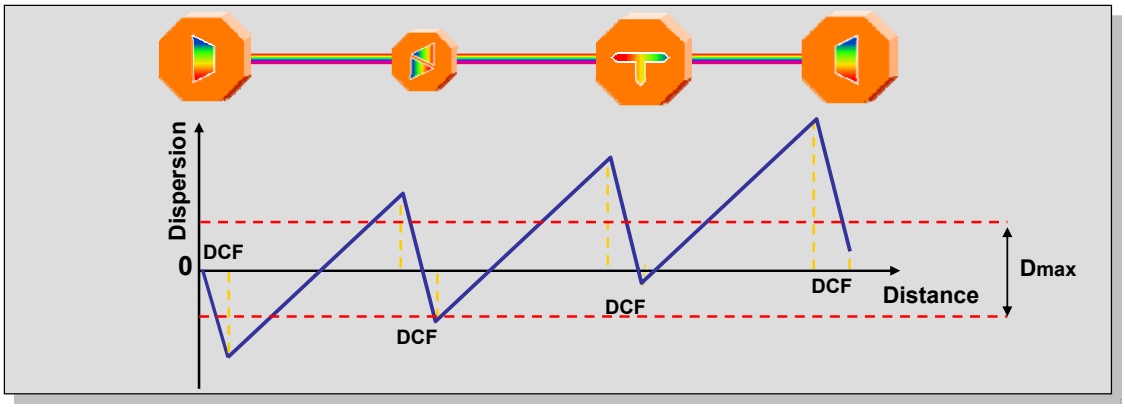

Fig. 60 Dispersion compensation scheme

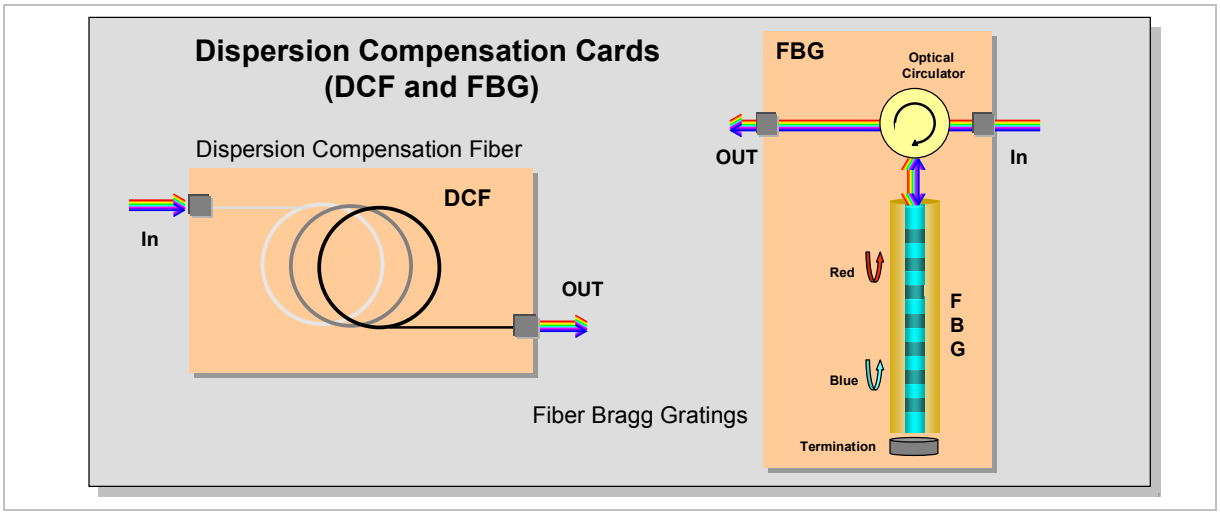

Fig. 61 Dispersion Compensation Cards

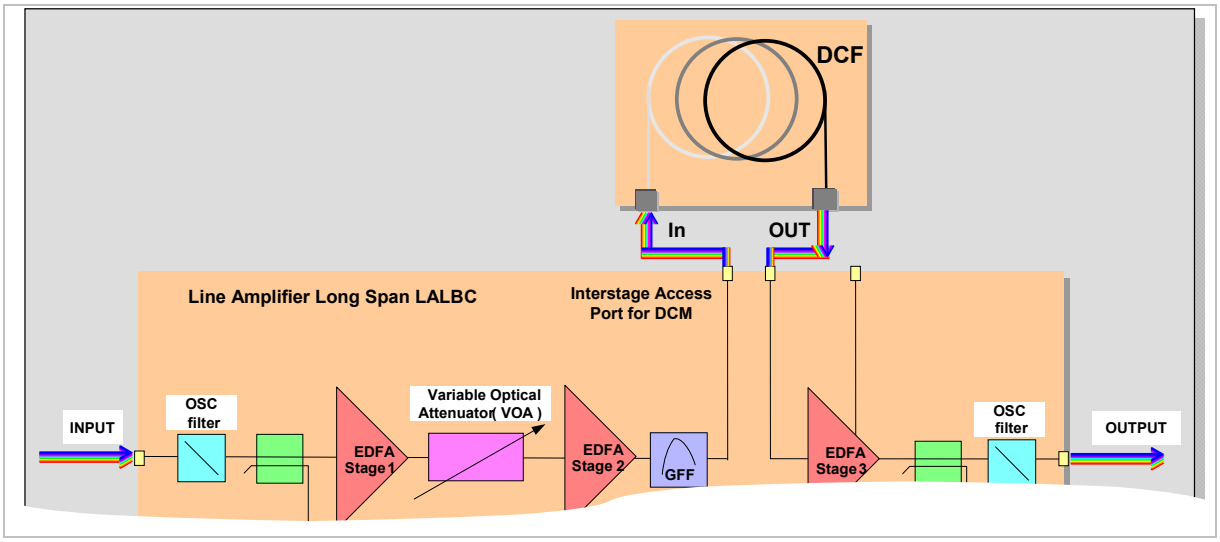

Fig. 62 Example of DCM usage

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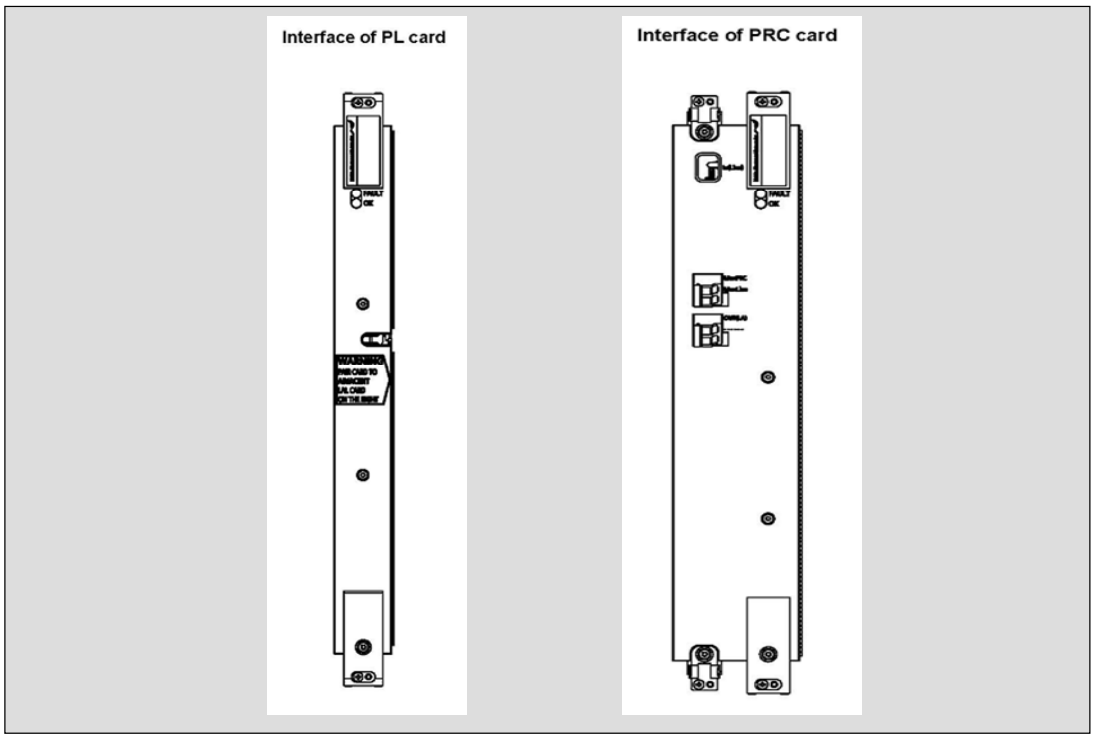

Fig. 63 HW layout

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2.5 Transponder, Muxponder, and Regenerator Functions

Each transponder or muxponder (=multiplexing transponder) converts one or several of its client signals of grey or CWDM wavelength into a colored line signal with specific DWDM wavelength according to the hiT7300 wavelength plan. Each transponder line interface provides an excellent span performance for regional as well as long haul networks by using optical DWDM modules with high dispersion tolerance in combination with FEC or SUPER-FEC ((SUPER-) Forward Error Correction). Each transponder/muxponder card can also support optical channel protection (OChP) for its line interface(s), which allows carrier-class survivability for its client services.

2.5.1 hiT7300 Transponder, Muxponder, and Regenerator Cards

The SURPASS hiT7300 transponder, muxponder, and regenerator cards offer a broad range of fully transparent data transmission services for various user applications. They are designed for interfacing to optical channels of data rate levels 2.5 Gb/s and 10 Gb/s within an Optical Transport Network (OTN) and support all the fault supervision and performance monitoring functions according ITU-T G.709.

TIP

Note that SURPASS hiT7300 transponder cards can be used as integral part of SURPASS hiT7300 NE's, or alternatively for interworking with SURPASS hiT7500 or any other 3rd party DWDM equipment.

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The following transponder card types are supported:

Card name	Typical Line bit rate (Gbit/s)	Transport network	Error Correction	Type of hot-pluggable modules
I04T2G5	2.50	Regio	FEC	SFP & DWDM-SFP
I01T10G	10.00	LHD/LH/Regio/Regio80/Metro	FEC / S-FEC	XFP
I08T10G	10.00	LHD/LH/Regio/Regio80/Metro	FEC / S-FEC	SFP
I04TQ10G	10.00	LHD/LH/Regio/Regio80/Metro	FEC / S-FEC	XFP
I05AD10G	10.00	Regio	FEC	SFP & DWDM-XFP
I22CE10G	10.00	LHD/LH/Regio/Regio80/Metro	FEC / S-FEC	SFP, SFP+, XFP
I01T40G	40.00		S-FEC	---
I01R40G	40.00		S-FEC	---
I04T40G	40.00		S-FEC	XFP

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Card name	Typical Line bit rate (Gbit/s)	Transport network	Error Correction	Type of hot-pluggable modules
I04T2G5	2.50	Regio	FEC	SFP & DWDM-SFP
I01T10G	10.00	LHD/LH/Regio/Regio80/Metro	FEC / S-FEC	XFP
I08T10G	10.00	LHD/LH/Regio/Regio80/Metro	FEC / S-FEC	SFP
I04TQ10G	10.00	LHD/LH/Regio/Regio80/Metro	FEC / S-FEC	XFP
I05AD10G	10.00	Regio	FEC	SFP & DWDM-XFP
I22CE10G	10.00	LHD/LH/Regio/Regio80/Metro	FEC / S-FEC	SFP, SFP+, XFP
I01T40G	40.00		S-FEC	---
I01R40G	40.00		S-FEC	---
I04T40G	40.00		S-FEC	XFP

Fig. 64 Multipurpose Modular Transponder, Muxponder, and Regenerator Cards

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The table on the next page gives an overview of the different transponder cards with their possible client interfaces.

For the 10G transponder/muxponder cards, the following optical variants of the 10G colored line interfaces are available on the respective card variant as denoted by the following suffixes:

- Metro: optimized for passive metro networks with 40 channels (up to 80 km reach) using fixed wavelength;
- Regio: optimized for regional networks (up to 600 km reach w/ optical amplifiers) with fixed wavelength;
- Regio80: optimized for regional networks with 40/80 channels (up to 600 km reach w/ optical amplifiers) using fixed wavelength;
- LH: optimized for long haul networks (up to 1600 km reach w/ optical amplifiers) with tunable wavelength;
- LHD: optimized for ultra long haul networks with 40/80 channels (up to 2000 km reach w/ optical amplifiers) using tunable wavelength, and with increased chromatic and polarization mode dispersion tolerance by MLSE (Maximum Likelihood Sequence Estimation) signal processing;
- LHS: optimized for long haul networks (up to 1600 km reach w/ optical amplifiers) via sea cable system with tunable wavelength;
- LHDS: optimized for ultra long haul networks with 40/80 channels (up to 2000 km reach w/ optical amplifiers) via sea cable system using tunable wavelength, and with increased chromatic and polarization mode dispersion tolerance by MLSE (Maximum Likelihood Sequence Estimation) signal processing;
- DPS: Modulation is DPSK: Differential Phase Shift Keying used by 40Gbit/s cards
- CQP: Modulation is CP-QPSK: Coherent Polarization Differential Quad Phase Shift Keying used by 40 Gbit/s cards for DCM free transmission.
- CQPS: like CQP but for sea cable application

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Overview of available Client Interfaces

	STM-1	STM-4	STM-16	STM-64	STM-256	1 GE	10 GE	FC-1G	FC-2G	FC-4G	FC-8G	FC-10G	any- rate 100M-3.4G	OTU-1	OTU-2	OTU-3
I04T2G5	X		X			X		X	X					X		
I08T10G			X			X								X		
I01T10G				X			X								X	
I04TQ10G				X			X				X	X			X	
I05AD10G	X	X	X			X				X			X			
I22CE10G						X	X									
I01T40G-1 (/CQP)					X											X
I04T40G-1 (/CQP)				X			X								X	

- SAN services certification: IBM System Storage Proven™

For internal use

Fig. 65 Transponder cards with possible line and client interfaces

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2.5.1.1 I04T2G5-1 card

The 2.5G transponder/muxponder functionality is realized by the I04T2G5-1 card. The card provides the following traffic interfaces:

- 2 pluggable (SFP modules) DWDM line ports;
- 4 pluggable (SFP modules) client ports for the following client interface types:
  Up to 2x STM-16/OC-48, or up to 4x GE (1000Base-X/T), or up to 4x FC 1G, or up to 2x FC 2G, or up to 2x OTU-1 (w/o FEC).

All traffic ports are realized hot pluggable SFP modules which can be equipped depending on the specific traffic demands for this card, thus providing lowest CAPEX by a single card type for many different applications. For optical client ports, both uncolored and CWDM interfaces are supported.

The electrical and optical Gigabit Ethernet (GbE) SFP interfaces available for the client ports of the I04T2G5-1 card.

The card can be used as transponder/muxponder or as 3R-regenerator card, depending on its configuration.

In case the I04T2G5-1 operates as a transponder/muxponder card, the card offers access for 1 or 2 optical channels with OTU-1 standard data rate (2.67 Gb/s) and FEC acc. ITU-T G.709 at its line interfaces. The required wavelength, which has been determined by the TransNet planning tool, is realized by plugging the correct DWDM SFP module, which is verified by the NE's controller function.

In case the I04T2G5-1 operates as a 3R-regenerator card, only the two line interface modules are equipped for bidirectional regeneration of an OTU-1 optical channel.

The 2 OTU-1 line interfaces can also be configured for optical channel protection.

The I04T2G5-1 transponder/muxponders implements standard compliant mapping schemes of all client signals types into an OTU-1 optical channel acc. ITU-T G.806 and G.709.

In case of Gigabit Ethernet (GE) or 1 Gigabit FiberChannel (FC-1G) client signals, 2 client signals are mapped into the OPU1 payload of an OTU-1 optical channel via GFP-T generic framing procedure and GFP-T frame multiplexing acc. ITU-T G.7041. This provides a fully transparent transmission of GE services at wire speed over the optical transport network and at the same time achieves efficient bandwidth utilization of the OTU1 optical channel. Mapping via GFP-T avoids any intermediate mapping into SDH/SONET layers and thus simplifies management of GE services. Fault supervision and performance monitoring are possible at OCh and Ethernet/FiberChannel layers for monitoring GE/FibreChannel traffic in both ingress and egress directions.

In case of an STM-16/OC-48 SDH/SONET client signal, one such client signal is mapped into an OPU1 payload of an OTU-1 optical channel acc. ITU-T G.709.

In case of an OTU-1 client signal (IrDI), the ODU1 optical data unit is transparently passed between client and line interface for providing a transparent optical channel including payload and ODU1 overhead.

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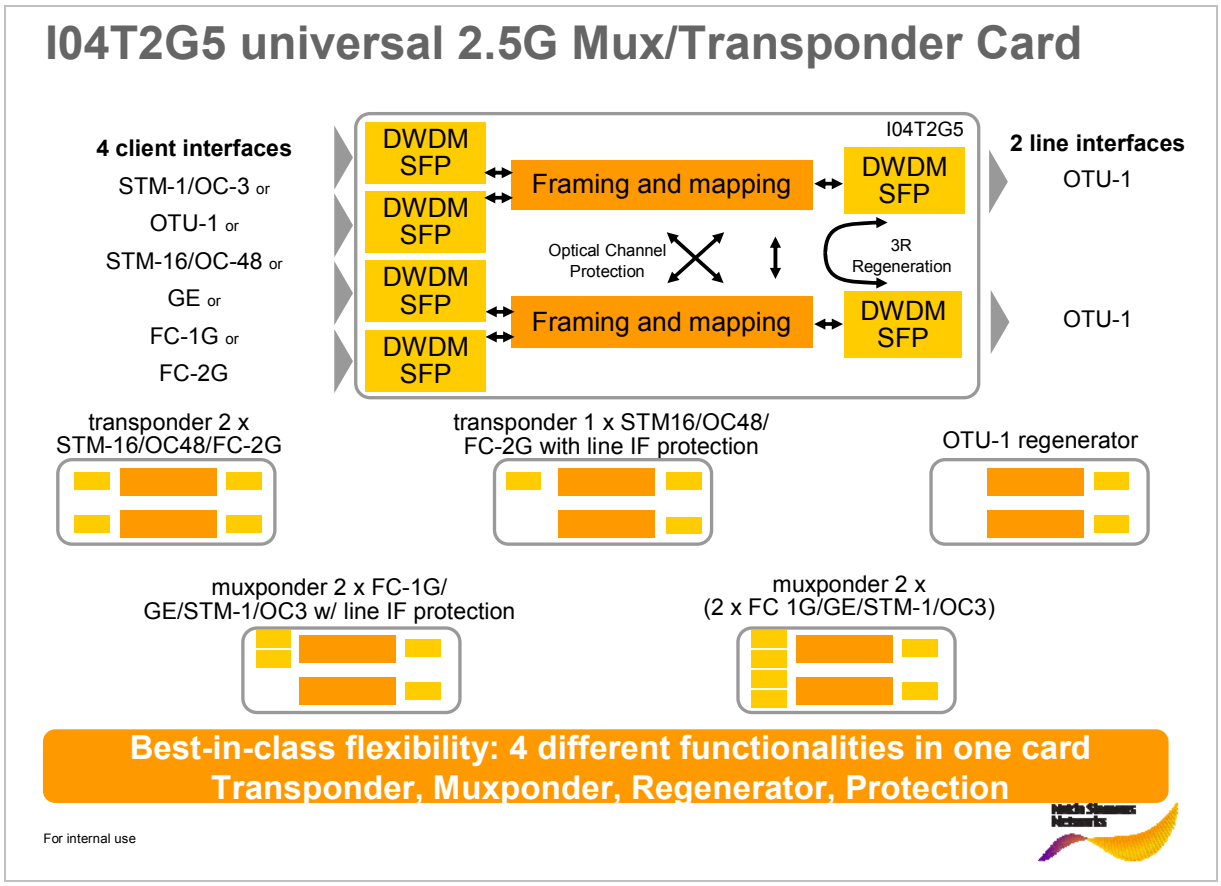

Fig. 66 2.5G Transponder/Muxponder/Regenerator Card I04T2G5

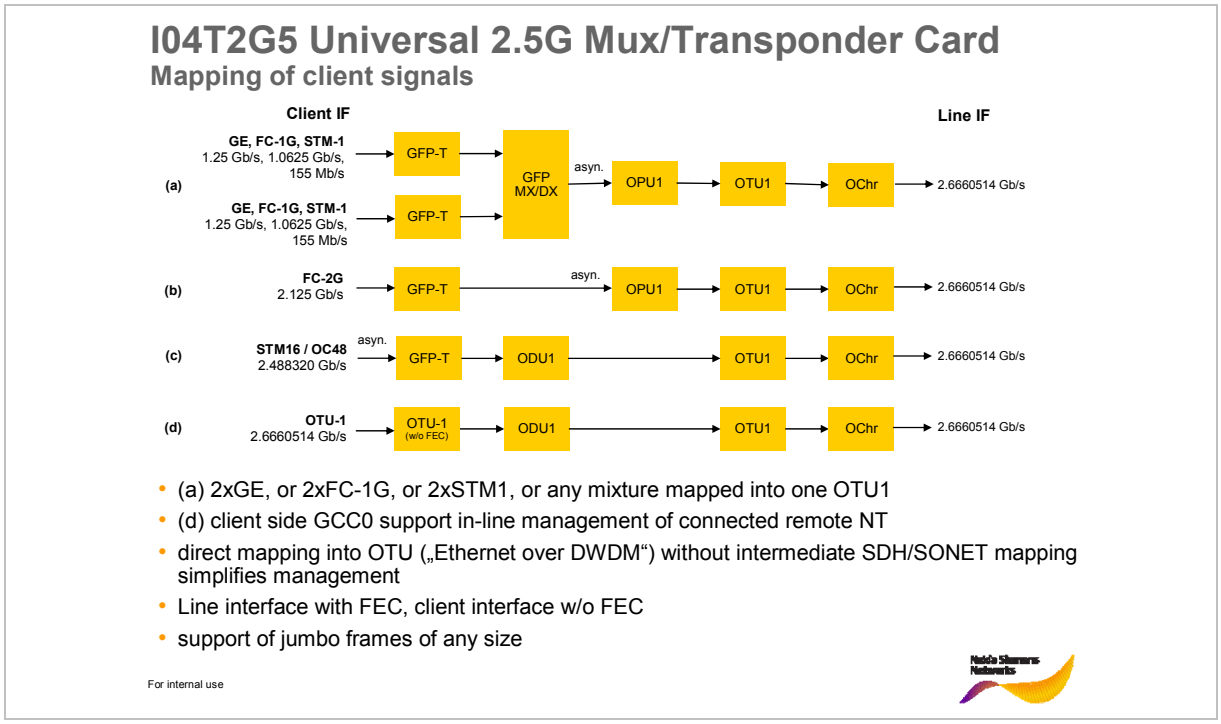

Fig. 67 Example of mapping Schemes of Client Signals to OTU-1 Optical Channel

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2.5.1.2 I01T10G-1 card

The 10G transponder functionality is realized by the I01T10G/LHD/LH/Regio/ Regio80/Metro cards. Each I01T10G-1 card generates and terminates an optical channel of a wavelength appropriate for DWDM transmission. The exact wavelength is controlled via a tunable transmit laser, (only available in the I01T10G-1 LH(S) and I01T10G-1 LHD card). The S-FEC feature allows longer span distances.

The I01T10G-1 LH card is equipped with a Mach Zehnder Modulator (MZM), temperature-controlled and wavelength tunable laser, with wavelength accuracy suitable for 50 GHz and 100 GHz DWDM channel spacing.

The I01T10G-1 LHD card can handle a higher dispersion and a higher PMD load, by using a Maximum Likelihood Sequence Estimator (MSLE).

The optical 10 Gbit/s client interfaces of the I01T10G-1 Regio/LH(S)/LHD card are equipped with one hot-pluggable 10 Gigabit Small Form Factor Pluggable (XFP) module mounted on the front panel of the card. The XFP module, like the SFP, performs the optical/ electrical conversion in both signal directions.

The card can also be used as a 3R-regenerator by back-to-back configuration of two I01T10G via the OTU-2 clients.

The I01T10G-1 transponder implements a standard compliant mapping scheme for STM64/OC192 signals into an OTU-2V optical channel acc. acc. ITU-T G.806 and G.709.

Since a standard 10 Gigabit Ethernet (10GE) LAN signal does not fit into the transport capacity of a standard OPU2 payload, the OPU2 transport capacity is increased using also OPU2 stuffing bytes for payload mapping and slightly increasing the OPU2/OTU2 data rate; by this means the 10GE LAN signal can be transparently transmitted at wire speed over the optical transport network. Fault supervision and performance monitoring are possible at OCh and Ethernet layers for monitoring 10GE traffic in both ingress and egress directions.

The SUPER-FEC scheme in combination with dispersion tolerant optical receiver provides an excellent dispersion tolerance for regional and long haul applications.

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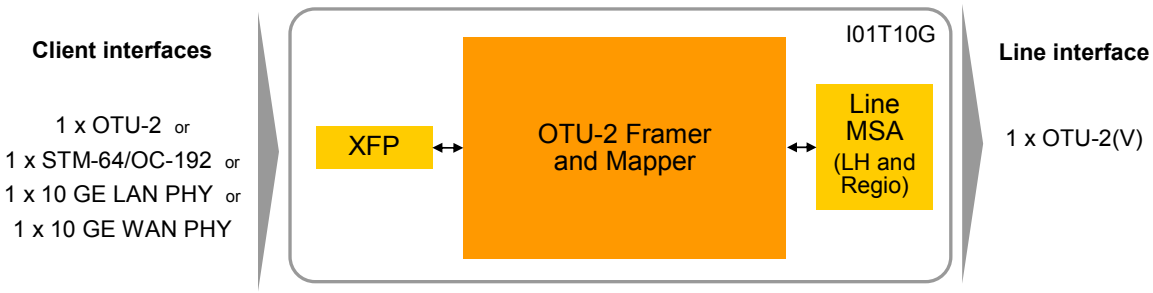
I01T10G OTU2 Transponder Card



10 Gb/s Transponder with full OTU-2 support

Super-FEC on line side with 8 dB coding gain

Multiple services supported service assignment for client ports

- STM-64 / OC-192
- Fully transparent 10 Gigabit Ethernet
- OTU-2

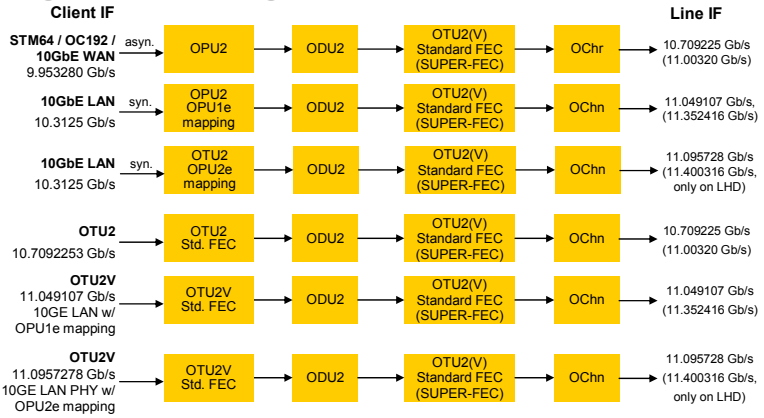
One board type can be equipped for Long Haul (full C Band tunable laser), Regio and Metro (fixed laser) applications

CD-tolerant version (for special fiber types) with +- 1500ps/nm @ 2dB penalty

For internal use

Fig. 68 10G Transponder Card I01T10G

I01T10G OTU2 Transponder Card
Mapping of client signals



- Standard FEC or Super FEC configurable for the Line IF
- (b) (e) OPU1e mapping mode acc. G.Sup43, utilizing OPU2 stuffing bytes and increased OTU2 data rate
- (c) (f) OPU2e mapping mode, not utilizing OPU2 stuffing bytes but increased OTU2 data rate
- (d) (e) (f) Client side Std. FEC support direct client side interconnect to WDM system
- (d) (e) (f) client side GCC0 support in-line management of connected remote NT
- support of jumbo frames of any size

For internal use

Fig. 69 Mapping of 10G Transponder Card I01T10G

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2.5.1.3 I08T10G-1 Card

The 10G muxponder functionality is realized by the I08T10G/ LHD/LH/Regio/Regio80/Metro cards.

The card provides the following traffic interfaces:

- 1 DWDM line port with tunable wavelength long haul interface for I08T10G/LH and I08T10G/LHD, where LHD refers to a specific card variant with high dispersion tolerance and S stands for see cable application, or fixed wavelength regional interface for I08T10G/Regio card type;
- 8 pluggable (SFP modules) client port for the following client interface types:
  4x STM-16/OC-48, or
  8x GE (1000Base-X/T), or
  4x OTU-1 (w/o FEC).

TIP
Also mixed client interfaces are possible, different client interfaces can be chosen per individual ODU1 data unit within the aggregate ODU2 data.

The client traffic ports are realized as hot pluggable SFP module which can be equipped depending on the specific traffic demands for this card, thus providing lowest CAPEX by a single card type for many different applications. For optical client ports, both uncolored and CWDM interfaces are supported.

The SUPER-FEC scheme in combination with dispersion tolerant optical receiver provides an excellent dispersion tolerance for regional and long haul applications.

The I08T10G-1 transponder implements a standard compliant mapping scheme of all client signals into an OTU-2V optical channel acc. acc. ITU-T G.806 and G.709.

In case of Gigabit Ethernet (GE) client signals, 2 client signals are mapped into the OPU1 payload of an ODU1 data unit via GFP-T generic framing procedure and GFP-T frame multiplexing acc. ITU-T G.7041. This provides a fully transparent transmission of GE services at wire speed over the optical transport network and at the same time achieves efficient bandwidth utilization of the OTU1 optical channel. Mapping via GFP-T avoids any intermediate mapping into SDH/SONET layers and thus simplifies management of GE services. Fault supervision and performance monitoring are possible at OCh, STM16/OC48 and Ethernet layers for monitoring client traffic in both ingress and egress directions.

In case of an STM-16/OC-48 SDH/SONET client signal, one such client signal is mapped into an OPU1 payload of an ODU1 data unit acc. ITU-T G.709.

In case of an OTU-1 client signal (IrDI), the ODU1 optical data unit is transparently passed between client and aggregate line interface for providing a transparent optical channel including payload and ODU1 overhead.

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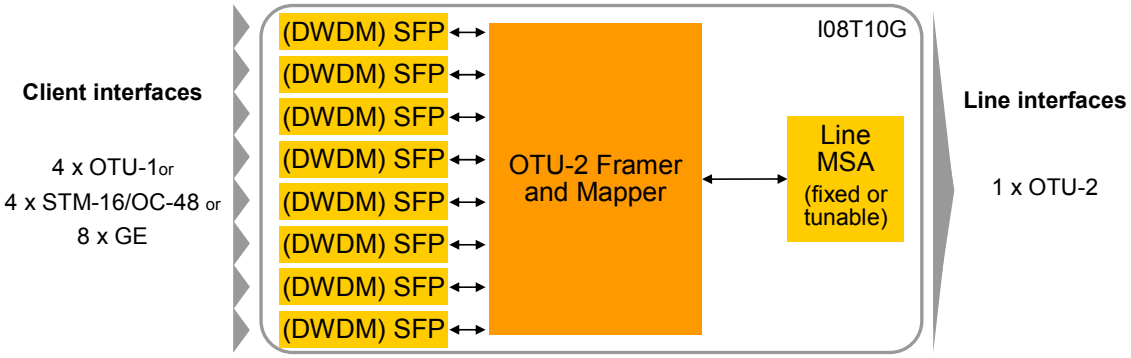
I08T10G Muxponder card with 10G Line

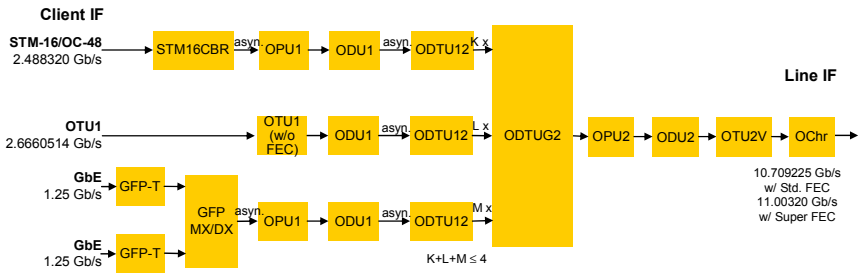


- 10G muxponder with full ODU-2 support
- 8 SFP grey/C/DWDM clients:
  - 4x STM-16/OC-48, or
  - 8x GE (1000Base-X/T), or
  - 4x OTU-1 (w/o FEC)
- Super-FEC on line side with 8 dB coding gain
- One board type can be equipped for Long Haul (full C Band tunable laser), Regio and Metro (fixed laser) applications
- CD-tolerant version (for special fiber types) with +- 1500ps/nm @ 2dB penalty

For internal use

Fig. 70 10G Muxponder Card I08T10G

I08T10G Muxponder card with 10G Line
Mapping of client signals



- Standard FEC or Super FEC configurable for the Line IF
- (b) OTU1 framed client format fully compatible with I04T2G5 OTU1 signal (direct interconnect supported)
- (b) client side GCC0 support in-line management of connected remote NT
- (c) GFP-T framing for wire speed transmission of GE clients
- (c) GE clients are directly mapped into OTU („Ethernet over DWDM“) without intermediate SDH/SONET mapping to simplify management

For internal use

Fig. 71 Mapping of 10G Muxponder Card I08T10G

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Fig. 72 Transponder HW layout

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2.5.1.4 I05AD10G-1 Card

With the release R4.2x, *SURPASS hiT 7300* supports a new type of multiplexing transponder card which allows an easy and efficient implementation of multi-service aggregation and distribution networks for various lower rate data services, which is required in typical backhaul applications within mobile networks and DSL provider networks. The I05AD10G card performs time division multiplexing of different client data services in combination with add/drop functionality into colored 10G optical channel signals for direct transmission over metro and regional DWDM networks. This 1-slot card has a total capacity of 9xGE or 2x 4G FC per OTU-2 channel. See following Figure for a simplified block diagram of this card. The card is also referred to as 'ADM on a blade'.

Line Interfaces:

2 pluggable (XFP modules) DWDM line ports for interface type:

- 2x OTU-2 (w/ standard FEC);

available as Regio or Metro type depending on optical reach requirements. For special applications, also grey (non-colored) C/DWDM XFPs can be equipped. At the network (line) side the card offers access for 1 or 2 optical DWDM channels with OTU-2 standard data rate (10.7 Gb/s) and FEC acc. ITU-T G.709. The required wavelength is realized by plugging the correct DWDM XFP module, which is verified by the NE's controller function. The 2 OTU-2 line interfaces can also be configured for optical channel protection (OChP, see Chapter 4) with respect to the individual multiplexed client services. In R4.30, the O02CSP-1 can be used for line side protection.

Client Interfaces:

5 pluggable (SFP modules) client ports for the following client interface types individually:

- up to 5x GE (1000Base-X/-T), or
- up to 4x FC/FICON 4G
- STM-1/OC3, STM4/OC12 or STM16/OC48 (new in 4.30)
- Anyrate muxponder / ADM (100 Mbit/s – 3.4 Gbit/s, free mix with other clients), new in 4.30

Also mixed client interface (e.g. 1x FC-4G +4x GE; 2x FC4G + 3x GE, 3x FC-4G + 2x GE) are possible.

All traffic ports are realized as hot pluggable SFP/XFP modules which can be equipped depending on the specific traffic demands for this card, thus providing lowest CAPEX by a single card type for many different applications.

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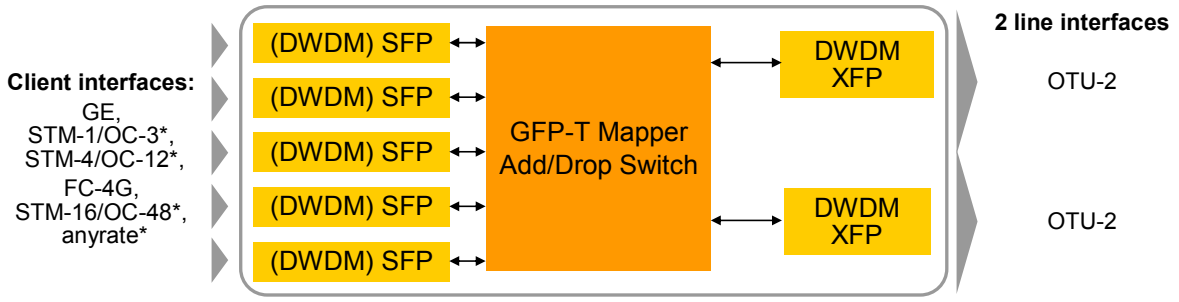
I05AD10G Multi-service Add-drop Multiplexer (ADM)



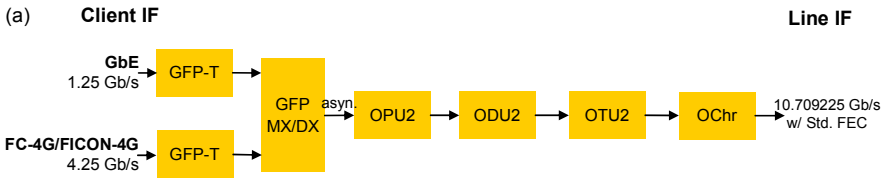
- Add/Drop Multiplexer (ADM) with dual Muxponder application
- grey/C/DWDM XFP based line ports
- grey/C/DWDM SFP based client ports for the following client interface types
  - up to 5x GE (1000Base-X/-T), STM-1/OC-3*, STM-4/OC-12*,
  - up to 4x FC-4G / FICON 4G, STM-16/OC-48*
  - mixed client interfaces
  - Anyrate clients (100 Mbit/s – 3.4 Gbit/s, free mix with other clients)*
- Direct optical connection of I05AD10G to I01T10G, I04TQ10G and I04T40G
- 1 slot card, Total capacity per OTU-2: 9xGE or 2x 4G FC
- GFP Channel Protection via second line port
- Drop & Continue / Broadcast Function

* Rel.4.3

For internal use

Fig. 73 10G Multiservice Add-drop Multiplexer Card I05AD10G

I05AD10G Multi-service Add-drop Multiplexer (ADM)



- Standard FEC on the OTU2 line IF
- GFP-T framing for wire speed transmission of GE clients (L2 functionality handled by I22CE10G)
- GE clients are directly mapped into OTU („Ethernet over DWDM“) without intermediate SDH/SONET mapping to simplify management

Fig. 74 Mapping of 10G Multiservice Add-drop card I05AD10G

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2.5.1.5 I04TQ10G-1 Card

The I04TQ10G-1 offers in a high degree of flexibility in 10G planning by supporting various application scenarios. The module can be operated as a quad transponder with 4 independent transponders and many different clients, the following configurations are possible:

- 4x independent transponders with any mix of clients
- 2x transponders with channel protection

General properties:

- Up to 8 interfaces total, 4 line and 4 client interfaces, operated with 6 XFPs and 2 SFP+
- Up to 2 client XFPs configurable for line side, SFP+ for client only
- Pluggable modules supported (XFP for line, SFP+ for client)
- 1 slot card width, either in standard or flatpack shelf
- Interface can be sub-equipped

Line side functionality:

Reach up to 1000km can be achieved with pluggable XFPs for Regio (fixed or tuneable wavelengths) and ULH (future). 40 or 80 channel capacity can be achieved. The OTU2V interface with 10% overhead for SFEC is available or the OTU2 interface with standard FEC. Also, support of GCC0 for management purposes.

Client side functionality:

- 10 GE LAN PHY – GFP-F mapping
- 10 GE LAN PHY – Semi-transparent GFP-F (AMCC) mapping
- STM-64/OC-192/10GE WAN PHY
- OTU2 with standard FEC, GCC0, TCM
- FC 8G (8.5GBit/s), for SFP+ only
- FC 10G (10.51875 GBit/s)

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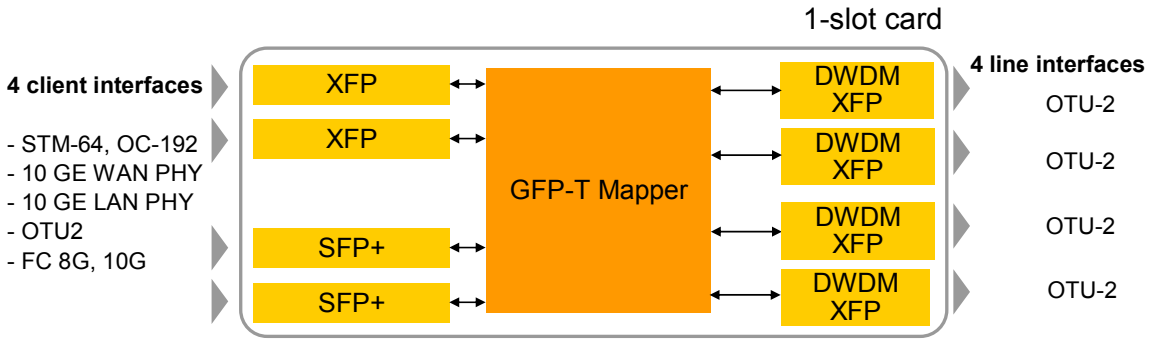
I04TQ10G: Quadruple 10G transponder



- Line side with fixed or tunable WDM XFP (40ch / 80ch option)
- Approximately 1000 km reach
- Power consumption of < 20 Watt per 10G service
- 80 wavelength terminal in 2 shelves
- Double regenerator functionality (client XFPs as line XFPs for this mode)
- Prepared for internal channel protection (>4.30)

For internal use

Fig. 75 10G Muxponder Card I04TQ10G

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2.5.1.6 I22CE10G-1 Card

The I22CE10G provides a very compact carrier Ethernet switch device, fully integrated within the hiT7300 DWDM platform for Packet Optical Transport. Starting from R 4.30, this I22CE10G traffic card is used for Carrier Ethernet Switch types and provides L2 functions, services and interfaces. Extended switching capacity can be achieved by stacking the card.

General benefits:

- The use in hiT7300 enables integrated CE over WDM
- Saving floor space, no extra rack and equipment is required
- Handling of DWDM and carrier Ethernet switch functionality with one single network management system for simplified operation and trouble shooting

This interface card offers 22 Carrier Ethernet (CE) ports. Four of the 10 GbE ports can be configured as DWDM ports (OTU2) with 10G transmission. The Ethernet switching capacity is 76G (California count 152G).It offers enhanced L2 processing for 1GE and 10GbE client services. Note that in hiT7300 the usage of carrier Ethernet transport (CET) is also possible with the existing transponders and muxponder cards but only the I22CE10G supports the statistical multiplex gain through switching of multiple Ethernet ports to and from OTN interfaces. The T-level slide sets contain more examples on the various applications for the L2 card, including switch stacking, service aggregation.

Line interfaces:

- 4x hybrid (grey/tunable) DWDM XFP based line ports
- 10GE over OTU-2 with Standard FEC, or 10GE interface configurable
- 1010GE mapping into OTU-2 acc. G.709, standard G.709 FEC or Super-FEC for enhanced reach
- Line interfaces also configurable as client interfaces

Client interfaces:

Client module: Several client interfaces (SFP for 1GbE, SFP+ for 10GbE), 10GbE PHY for 10GbE interfaces, Client CPLD for SFP/SFP+, LED handling

- up to 22 client ports possible in flexible configuration
- 16x 1GE and 2x 10GE client interfaces (up to 4 additional 10GE can be configured from line ports)
- Any port usable as UNI or NNI

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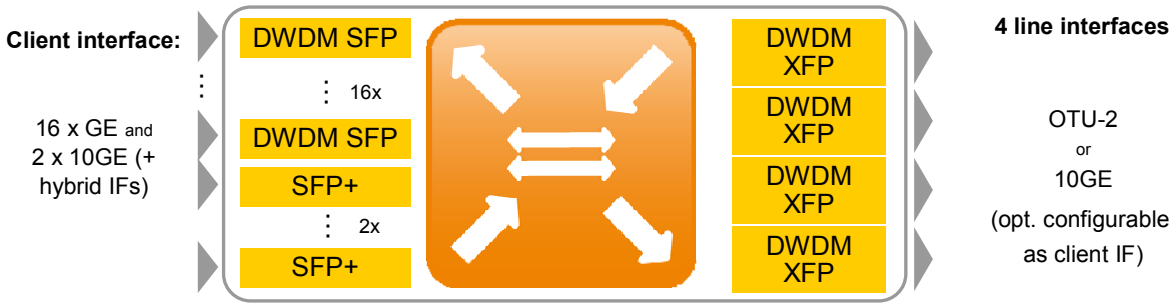
Metro CET Ethernet switch I22CE10G



- 76G Ethernet switch capacity (California Count 152G)
- Card protection option and ext. switching capacity via stacking of L2 cards
- 4x hybrid OTU-2 / 10GE interfaces (configurable trunk or client)
- 16x 1GE and 2x 10GE client interfaces, statistical multiplex
- Line interfaces are 10GE mapped into OTU-2 with (Super)-FEC
- Support for connection oriented Ethernet
  - Extended VLAN support
  - L2 MPLS support (R4.4)
  - E-LINE and E-LAN services acc. MEF-6
- 2 slot card

For internal use

Fig. 76 L2 Switch card I22CE10G

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2.5.1.7 I0xT40G Card

With release R4.25 SURPASS hiT 7300 supports the new 40G transponder cards

- I01T40G → 40Gbit/s on client interface
- I04T40G → 4x 10Gbit/s on client interface
- I01R40G → 40Gbit/s unidirectional regenerator card
- I02R40G-2/CQP → 40Gbit/s bidirectional regenerator card for CP-QPSK

From these cards there are different sub types:

- I0xT40G-1/DP → DPSK modulation
- I0xT40G-1/DPS → DPSK modulation for sea cable
- I0xT40G-1/CQP → CP-QPSK modulation
- I01T40G-2/CQP-I → CP-QPSK modulation with intra office (2km) client interface
- I01T40G-2/CQPS-I → CP-QPSK modulation for sea cable with intra office (2km) client interface
- I01T40G-2/CQP-S → → CP-QPSK modulation with short reach (10km) client interface
- I01T40G-2/CQPS-I → CP-QPSK modulation for sea cable with short reach (10km) client interface

The 40G cards which are fully integrated within the hiT 7300 mechanical shelf and rack solution and which is fully managed by the hiT 7300 NE controller. In R4.30, line protection with the new O02CSP-1 card is introduced.
These cards use on the line interface OTU3v with Super-FEC.

The I01T40G card provides the following traffic interfaces:

- 1x STM-258/OC-768, or
- 1x OTU-3 (w/ standard FEC insertion)

The I04T40G card provides the following traffic interface:

- 4x STM-64/OC-192, or
- 4x 10GE (10GBASE-R/-W, GBE LAN semitransparent), or
- 4x OTU-2 (w/ standard FEC insertion)
- Arbitrary mix of service types on client

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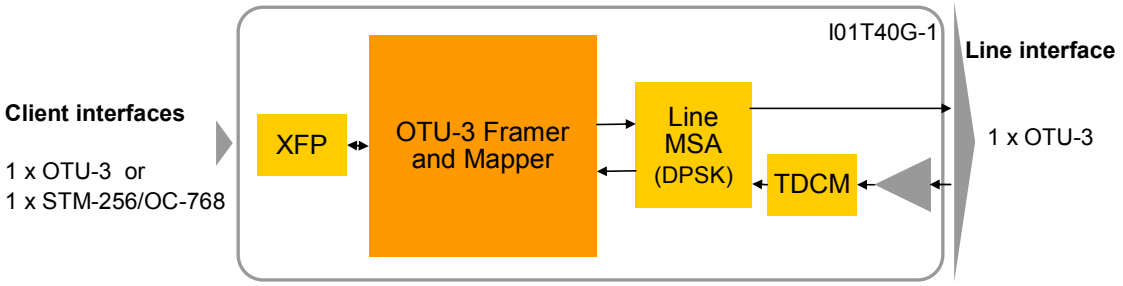
I01T40G-1
40G Transponder Card

Fully integrated card

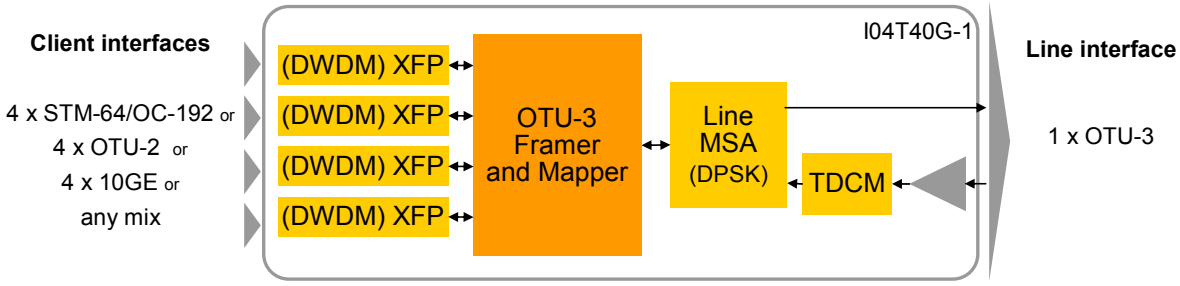


- 40 Gb/s Transponder with OTU-3 support
- Adaptive DPSK modulation format, full C band tunable laser
- Integrated dispersion compensation unit and pre-amplifier
- Optional external polarization mode dispersion (PMD) compensator
- Super Forward Error Correction (Super-FEC) on line side, appr. 8dB coding gain
- Services supported
  - STM-256 / OC-768
  - OTU-3

Fig. 77 40G Transponder Card I01T40G

I04T40G-1
40G Muxponder Card

Fully integrated card



- 40 Gb/s Transponder with OTU-3 support
- Adaptive DPSK modulation format, full C band tunable laser
- Integrated dispersion compensation unit and pre-amplifier
- Optional external polarization mode dispersion (PMD) compensator
- Super Forward Error Correction (Super-FEC) on line side with 7% overhead
- 4 x grey/C/DWDM XFP based client ports:
- 4x STM-64/OC-192 or
  - 4x 10 GbE LAN or 10GbE WAN or
  - 4x OTU-2 (with FEC)
  - or mixed configuration

For internal use

Fig. 78 40G Muxponder Card I04T40G

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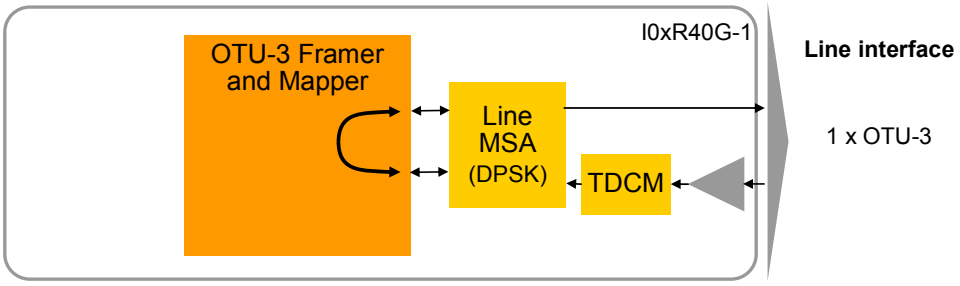
I0xR40G-1
40G Regenerator Card

Fully integrated card



- I01R40G-1 is a unidirectional regenerator card
- I02R40G-2/CQP is a bidirectional regenerator card for CP-QPSK
- 40 Gbit/sec unidirectional regenerator function via OTU-3 line interface (DPSK modulation format)
- Bidirectional regenerator function provided via 2 cards in adjacent slots

Fig. 79 40G Regenerator Card I0xR40G

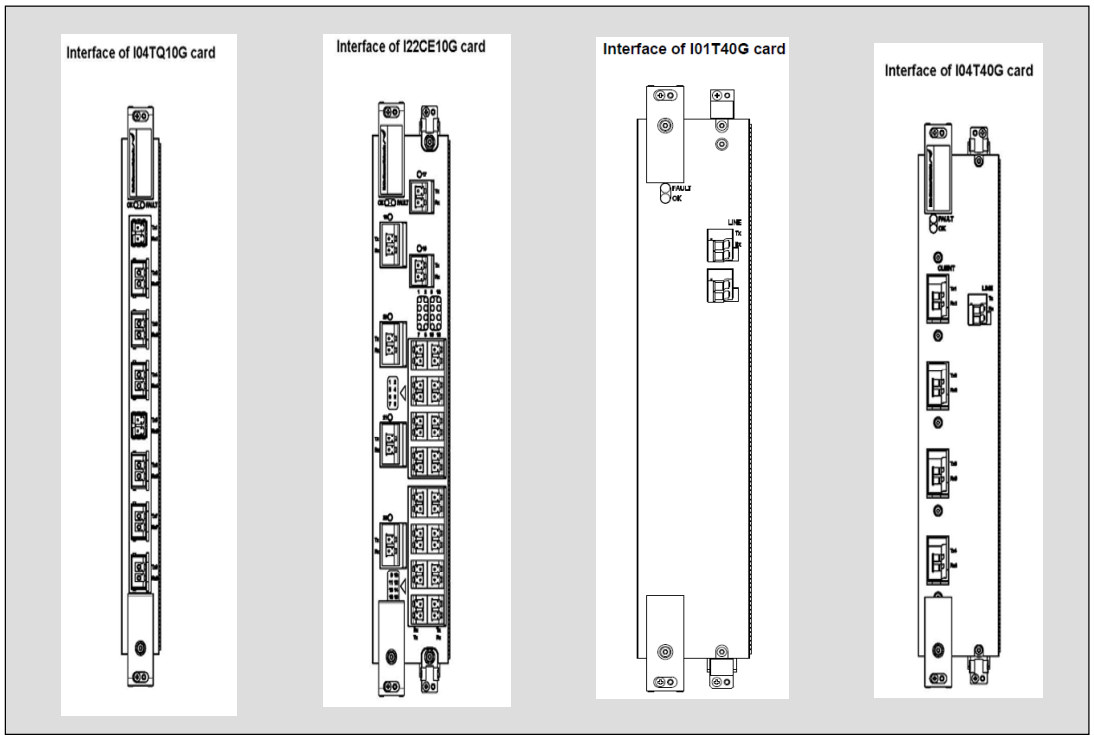


Fig. 80 40G Muxponder Card I04T40G

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2.6 hiT7300 Optical Protection

hiT7300 supports the following traffic protection options:

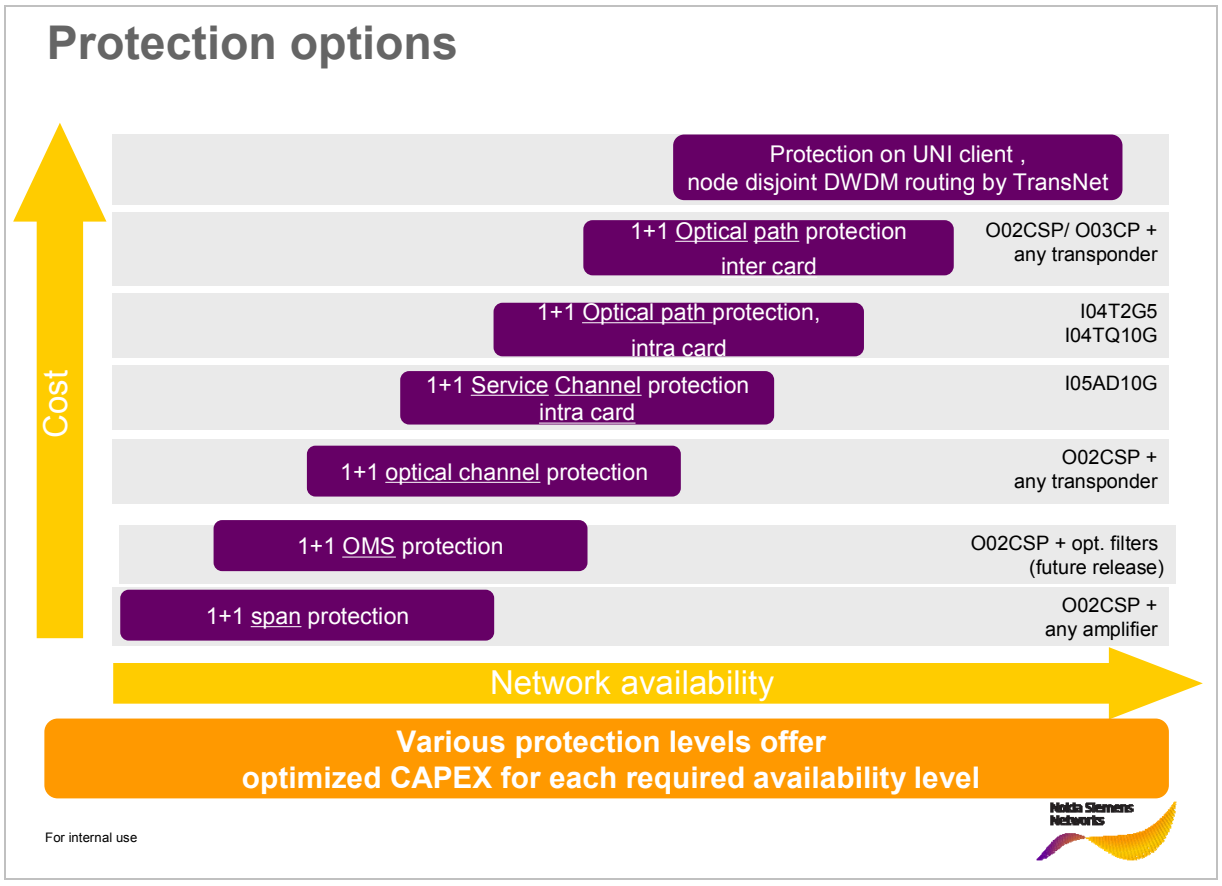

Fig. 81 hiT7300 Protection options

These options are:

- 1+1 Line protection without transponder protection
- 1+1 Service Channel protection without transponder protection
- 1+1 Optical Channel protection without transponder protection
- 1+1 Optical Channel protection with transponder protection
- 1+1 OMS protection
- 1+1 span protection

In order to achieve reasonable traffic survivability, working and protection paths of the OCh should be routed over physically diverse optical multiplex sections, which means that the necessary optical equipment (opt. multiplexer/de-multiplexer, opt. Amplifier) must be doubled.

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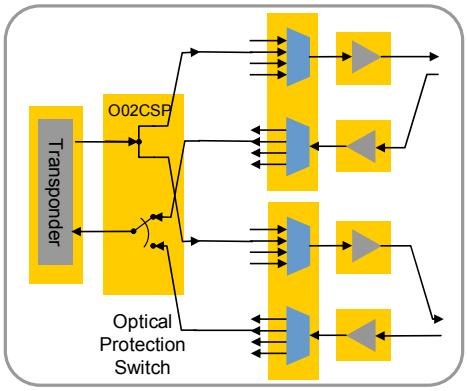
1+1 Line protection without transponder protection

Characteristics

- Protects the transponder line signal
- O02CSP protection card with transmit side splitter, receive side switch



Protects against

- Fibre cut, degradation on the optical line
- Protection against any failure of the optical system (filters, ROADM, amplifiers)
- Does not protect against any transponder failures

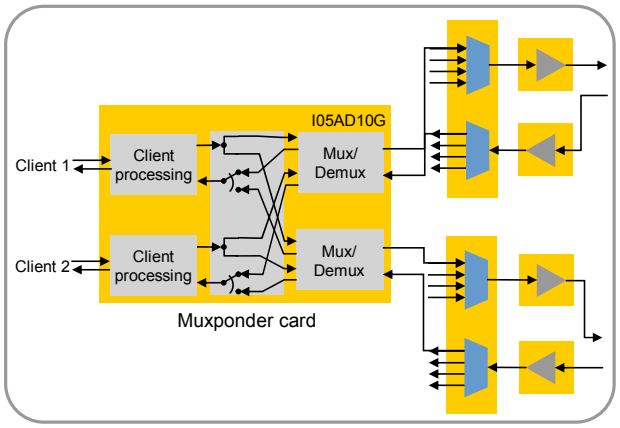
Lowest cost protection; best used for 40G transponder protection to avoid doubling expensive 40G transponders

Fig. 82 hiT7300 Protection options

1+1 Service Channel protection without transponder protection

Characteristics

- Protection of the transponder's optical client side, i.e. each individual client signal can be protected by one electrical protection switch
- Dual line side of transponder card I05AD10G is used as working and protection line sides
- No dedicated protection card necessary



Protects against

- Fibre cut, degradation on the optical line
- Equipment failures of all cards in the optical system (filters, ROADM, amplifiers) and of the transponder line interface (line side XFP)

**Ideal for transport of GE services;
can be combined with drop & continue for multicast**

Fig. 83 hiT7300 Protection options

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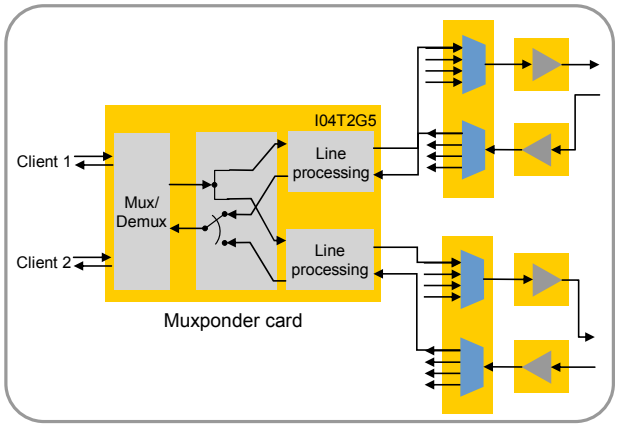
1+1 Optical Channel protection without transponder protection

Characteristics

- Protection of the transponder's optical line side, i.e. the complete transponder line signal is protected by one electrical protection switch
- Dual line side of transponder card I04T2G5 is used as working and protection line sides
- No dedicated protection card necessary



Protects against

- Fibre cut, degradation on the optical line
- Equipment failures of all cards in the optical system (filters, ROADM, amplifiers) and of the transponder line interface (line side SFP)

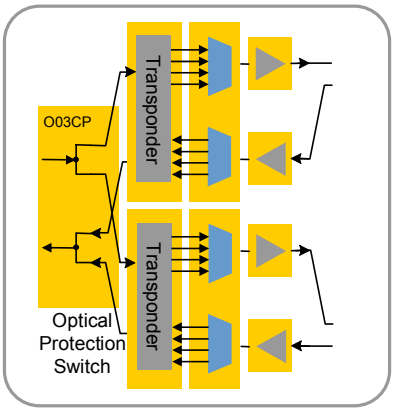
Ideal for transport of GE services

Fig. 84 hiT7300 Protection options

1+1 Optical Channel protection with transponder protection

Characteristics

- Protection on client side of the transponder
- For all 10/40G transponder cards
- One O03CP card protects up to 3 bi-directional signals



Protects against

- Fibre cut, degradation on the optical line
- Full transponder protection, and protection against any failure of the optical system (filters, ROADM, amplifiers)

Ideal for protection of highest value leased lines

Fig. 85 hiT7300 Protection options

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2.6.1 O02CSP-1, Dual protection card

Protection and compensator cards for OCh protection schemes are complemented in R4.30 by a dual protection card which contains two 2x1 switches and two power splitters. The O02CSP-1 in cooperation with one interface card will perform a 1+1 Line Side Optical Channel Protection (LS-OChP). The switching will be done actively by the O02CSP-1 card using an optical switch. In contrast, the O03CP is a purely passive card.

This is a 1-slot wide active card for two bidirectional 2-port channel protection units, each consisting of a splitter and a switch. All the inputs and the output of the switch are supervised by LOS monitors. The card is usable for line protection via the splitter and the switch. Within the actual version, the switch decision could be triggered by both; the operator via CCEP or autonomously via LOS detection. All LOS evaluation for the O02CSP is based on its own decisions. No communication is available between O02CSP and any other transponder card in 4.30. Hence, the O02CSP can handle any transponder. In addition to line side protection, the O02CSP-1 can also be used on the client side of a muxponder, as loss forwarding will be supported in 4.30. The protection has to be configured via LCT

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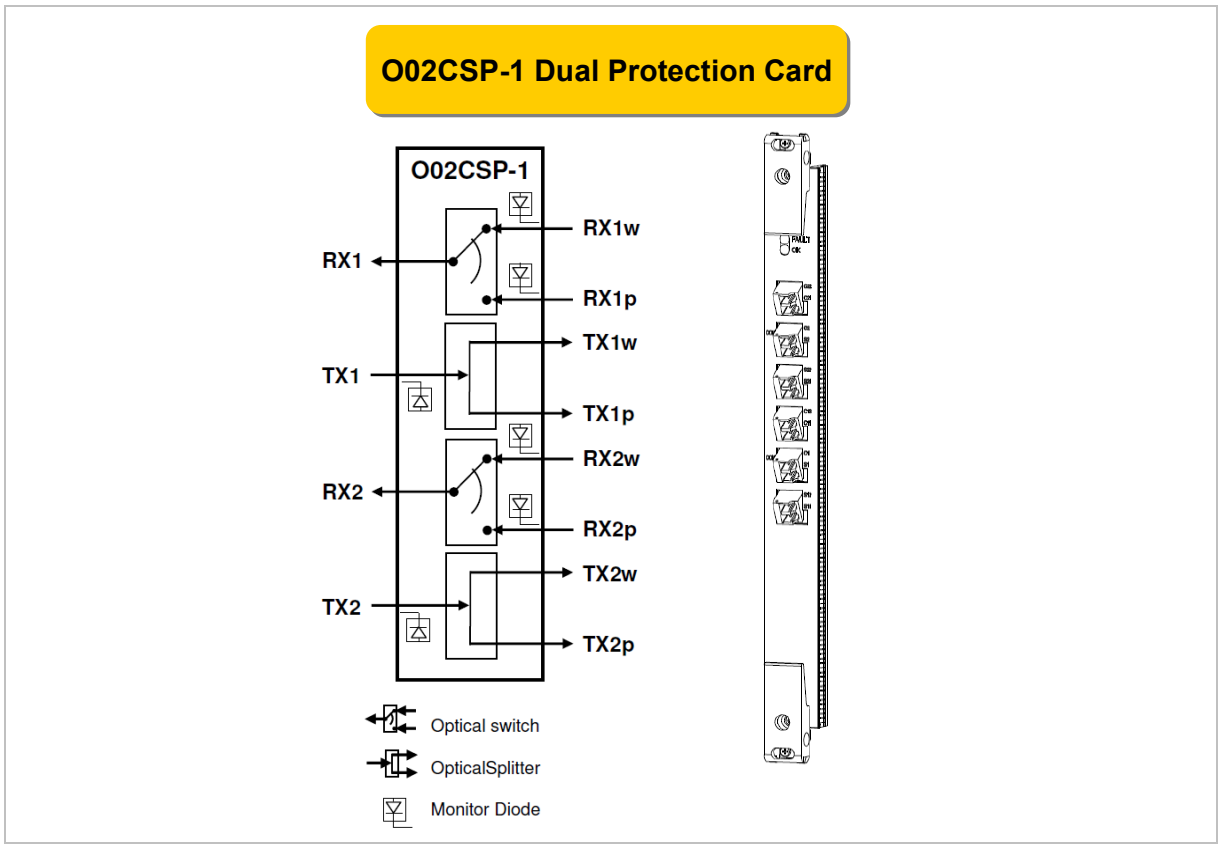

Fig. 86 O02CSP-1, Dual protection card

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2.6.2 O03CP-1, Optical channel protection card

A 1+1 ODU1 protection (ODU1P trail protection) is completely realized on the 2G5 transponder card I04T2G5 1 for a corresponding pair of working/protection OTU1 line interfaces on one transponder card. Protection switching is done on the electrical signal level for the ODU1 signal transmitted/received at the line side.

A 1+1 client protection of OTU2 Channels is realized by a pair of 10G muxponder cards I08T10G 1 or/and. transponder cards I01T10G 1 equipped in adjacent slots together with optical protection cards O03CP 1. Protection switching is done by on/off switching of the client laser at the transponder card. Only the client laser of the active path is enabled, the client laser of the protecting path is switched off. This requires communication between the two transponder cards. The active and the protecting path are combined at the O03CP 1 card.

As an example for the possible slot assignment of the muxponder/transponder cards see the following table:

Slot N.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1+1 client I08T10G-1	W		P		W		P		W		P					
1+1 client I01T10G-1	W	P	W	P	W	P	W	P	W	P	W	P	W	P		

The OChP card O03CP-1 is a passive card which contains 6 optical splitters. Three act as combiners to switch the traffic together with the 10 Gbit/s transponder cards. The remaining three are used for bridging the traffic for protection.

Up to three protection groups can be created and managed by the O03CP-1 card (i.e., three pairs of 10 Gbit/s transponder cards).

The O03CP 1 is a passive card.

The following table is giving the OChP card overview:

Card name	**Number of protected channels**	**Architecture**	**Communication type**
O03CP-1	3	3 splitters and 3 combiners	bidirectional

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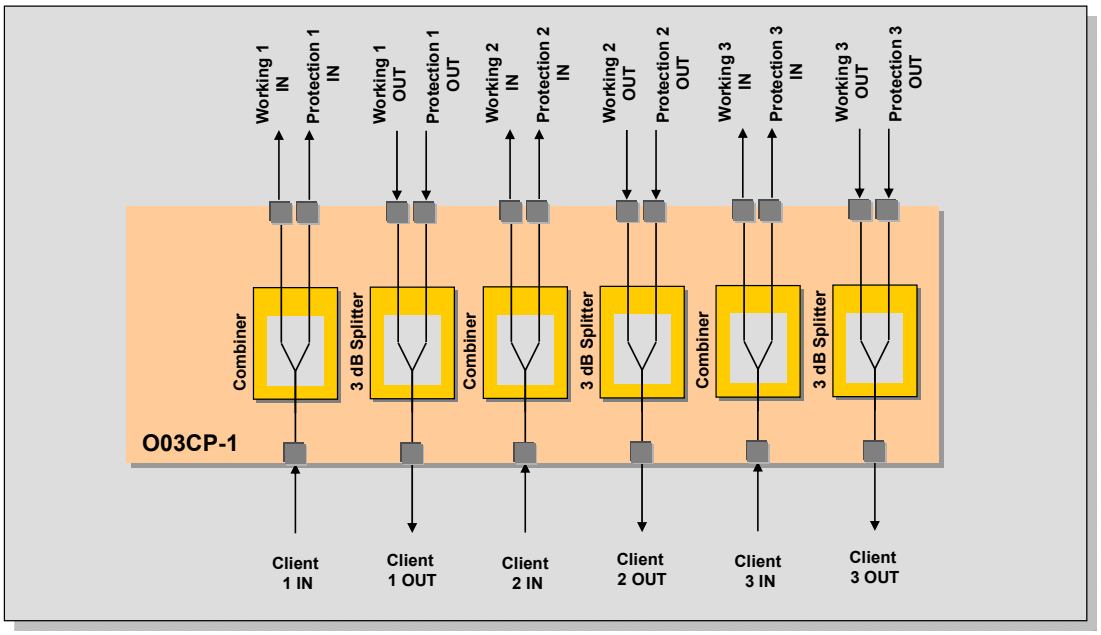

Fig. 87 O03CP-1, Optical channel protection card

Slot N.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1+1 client I08T10G-1	W		P		W		P		W		P					
1+1 client I01T10G-1	W	P	W	P	W	P	W	P	W	P	W	P	W	P		

Fig. 88 Possible slot assignment for transponder cards working as a protection pairs

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2.7 System management Function

2.7.1 Optical Supervisory Channel

SURPASS hiT7300 offers a 12.5 Mbit/s (≤ 4.30) or 150 Mbit/s (≥ 5.0) bandwidth Optical Supervisory Channel (OSC) to provide communications between all SURPASS hiT7300 NE's within OMS and OTS trails.

The optical supervisory channel is used for all data communication as needed for the configuration, fault management, performance management, as well as for any software management required to setup and maintain the NE's of the OTN.

The OSC is a bidirectional data channel whereby the same wavelength of 1510 nm is used for both transmission directions, each on a separate fiber. The OSC wavelength lies just outside the C-Band of the used optical channel wavelengths, and is terminated at each hiT7300 network element (ONN and OLR). Therefore, even in the rare occurrence of an optical amplifier failure, the OSC and hence all management communications remain intact.

The high optical performance of the OSC supports very long spans for up to 50 dB span attenuation at 1510 nm out-of-band OSC wavelength (corresponds to ~48.5 dB span attenuation for traffic wavelengths within C-Band) using LALBCH-1 booster amplifier card.

TIP
Since the version 5.0 the resilience of the OSC channel will be also improved by the FEC mechanism known from the transponder cards

The following table shows an overview of the functions supported by the OSC:

Optical Supervisory Channel (OSC) Functions:
Data communication channel for the internal Data Communications Network DCN (Ethernet based);
Link control information for initializing and maintaining of the optical OMS/OTS trails (e.g. number of equipped channels, current link states, etc.);
Control Information for Automatic Power Shutdown (APSD);
Two bidirectional User Channels (Ethernet based);
Two Engineering Orderwire (EOW) channels;
Trace Identifier for the optical OMS/OTS trail;
Forward / Backward Defect Indication (FDI / BDI) within OMS/OTS.

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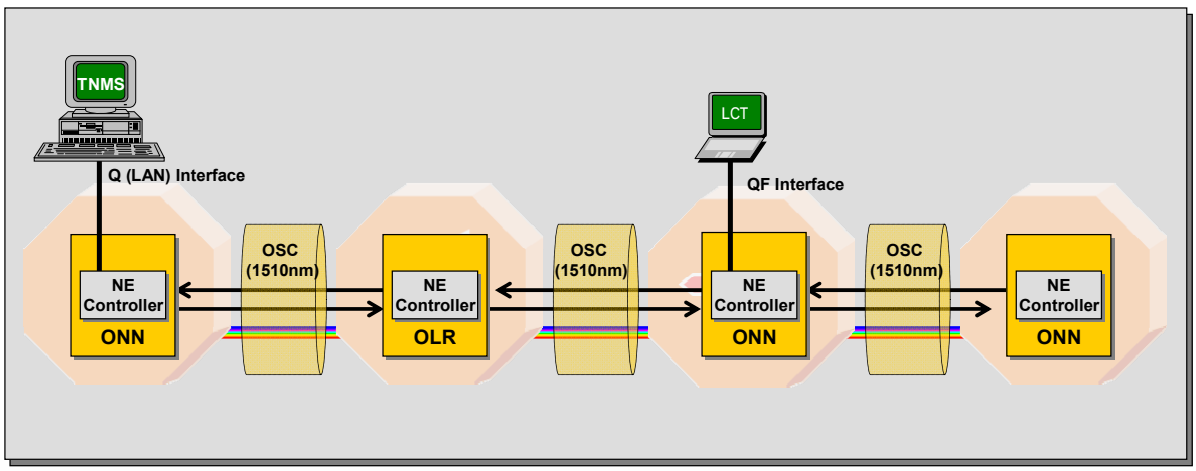

Fig. 89 Optical Supervisory Channel

Optical Supervisory Channel (OSC) Functions:
Data communication channel for the internal Data Communications Network DCN (Ethernet based);
Link control information for initializing and maintaining of the optical OMS/OTS trails (e.g. number of equipped channels, current link states, etc.);
Control Information for Automatic Power Shutdown (APSD);
Two bidirectional User Channels (Ethernet based);
Two Engineering Orderwire (EOW) channels;
Trace Identifier for the optical OMS/OTS trail;
Forward / Backward Defect Indication (FDI / BDI) within OMS/OTS.

Fig. 90 Optical Supervisory Channel (OSC) Functions

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2.7.2 Generic Communication Channels

The SURPASS hiT 7300 supports Generic Communication Channels of GCC0 type according to ITU-T G.709 for OTU-k interfaces of the SURPASS hiT 7300 transponder cards. The GCC0 channels can be used to extend the internal DCN of a transport network or for transmission of user channels in any customer specific application.

The GCC0 channels can be preferably used for data communication over passive CWDM/DWDM links or non-colored (grey) single channels, where no OSC channel exists for these purposes.

Bandwidth of GCC0:

- OTU1 → GCC0 326 kbit/s
- OTU2 → GCC0 1.3 Mbit/s
- OTU3 → GCC0 5.2 Mbit/s

A maximum of 1 GCC0 channels (OTU-2) and 4 GCC0 channels (OTU-1) are supported per transponder card. All the configured channels must belong either to the client(s) or the line(s) interface of the card.

A maximum of 26 GCC0 channels are supported per NE.

In the GCC0 channel two types of communication protocols are supported, which are configurable per NE:

- SURPASS hiT 7300 GCC0 mode: a GCC0 channel transports one internal DCN channel (as part of the SURPASS hiT 7300 internal DCN) and two user channels, all consisting of tagged Ethernet frames.
- SURPASS hiT 7500 GCC0 mode: a GCC0 channel transports one internal DCN channel for communication within a SURPASS hiT 7500 internal DCN, using an IP over PPP protocol stack compatible with SURPASS hiT 7500; this mode can be used for applications using a SURPASS hiT 7300 SON NE (as a remote network termination) with SURPASS hiT 7300 transponder cards as a feeder for a SURPASS hiT 7500 transmission network.

TIP

Each GCC0 channel supports two transparent Ethernet based user channels (in SURPASS hiT 7300 mode), which can be externally accessed by two RJ45 connectors on the controller card within the shelf containing the respective transponder card terminating the GCC0 channel.

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hiT 7300 GCC (Generic Communication Channel Facts

- Generic Communication Channels of GCC0 type according to ITU-T G.709
- GCC0 channels can be preferably used for data communication over passive CWDM/DWDM links
- Each GCC0 channel offers a bandwidth of 326 Kbit/s in OTU1 transponders (e.g., I04T2G5-1) and 1.3 Mbit/s in OTU2 transponders (e.g., I01T10G-1).
- A maximum of 1 GCC0 channels (OTU-2) and 4 GCC0 channels (OTU-1) are supported per transponder card
- All the configured channels must belong either to the client(s) or the line(s) interface of the card
- A maximum of 26 GCC0 channels are supported per NE

Fig. 91

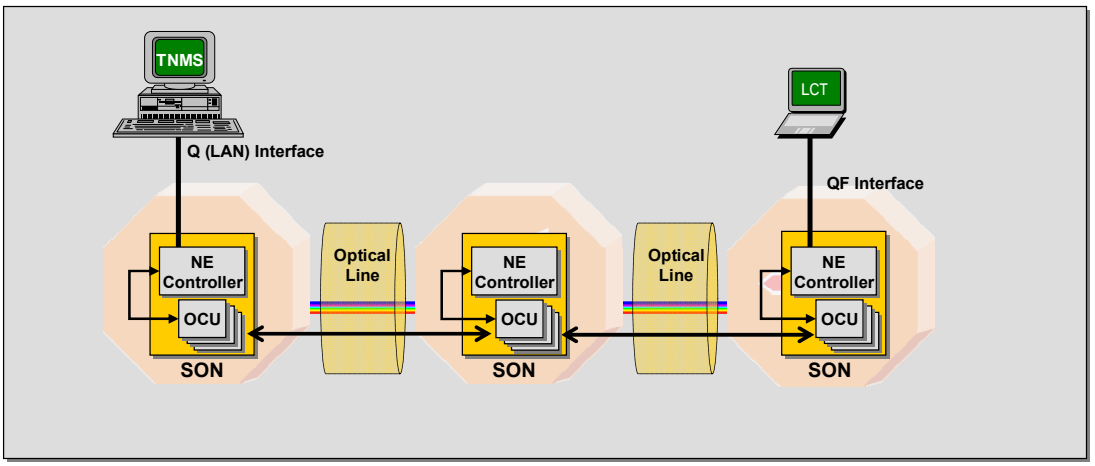

Fig. 92 Example of usage Generic Communication Channels

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2.7.3 Control and management Function

Optical link control is intended to ensure optimized optical link operation in any link state. The goals are to maintain sufficient link performance and consequently an equally distributed power level (with reference to the containing OSNR value) at each channel's tail end (at optical receiver or regenerator locations). Within each individual NE, the Controller card serves as central instance to manage and control all optical link relevant information. Controller cards within an optical link must exchange management information as well as measurement data between each other.

Two different types of link control are available since version 5.0:

- EPC: Enhanced Power Control this is the legacy behavior of the hiT7300.
- APC: Advanced Power Control is the behavior of the hiT7300 DCM free network (96 channels). The advantages are faster measurement cycles more automatic features.

TIP
Link management information and measurement data needed for controlling the optical link is exchanged between NE's via the optical supervisory channel.

NE external communication links and NE internal communication links are established to properly operate all optical link control mechanisms for the whole link and within the NE.

Within each shelf the Controller card communicates, with all "passive" cards (e.g., filter and attenuator cards), using the I2C bus. "Active" cards (e.g., line amplifier and Raman pump cards) use the amplifier-pump control bus to communicate with the Controller card.

The communication between shelves is achieved with two Ethernet LAN connectors on the Controller card.

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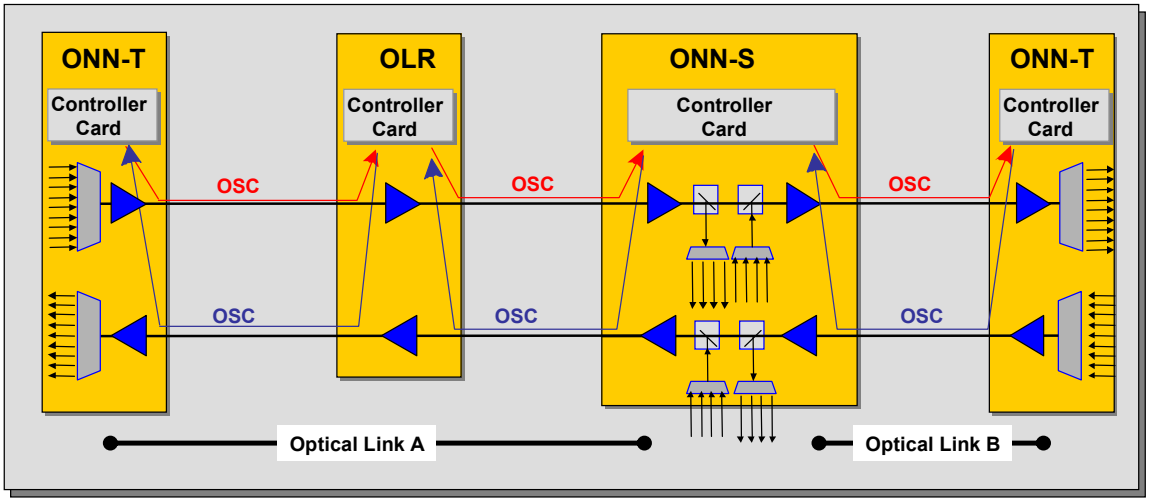

Fig. 93 Optical link control

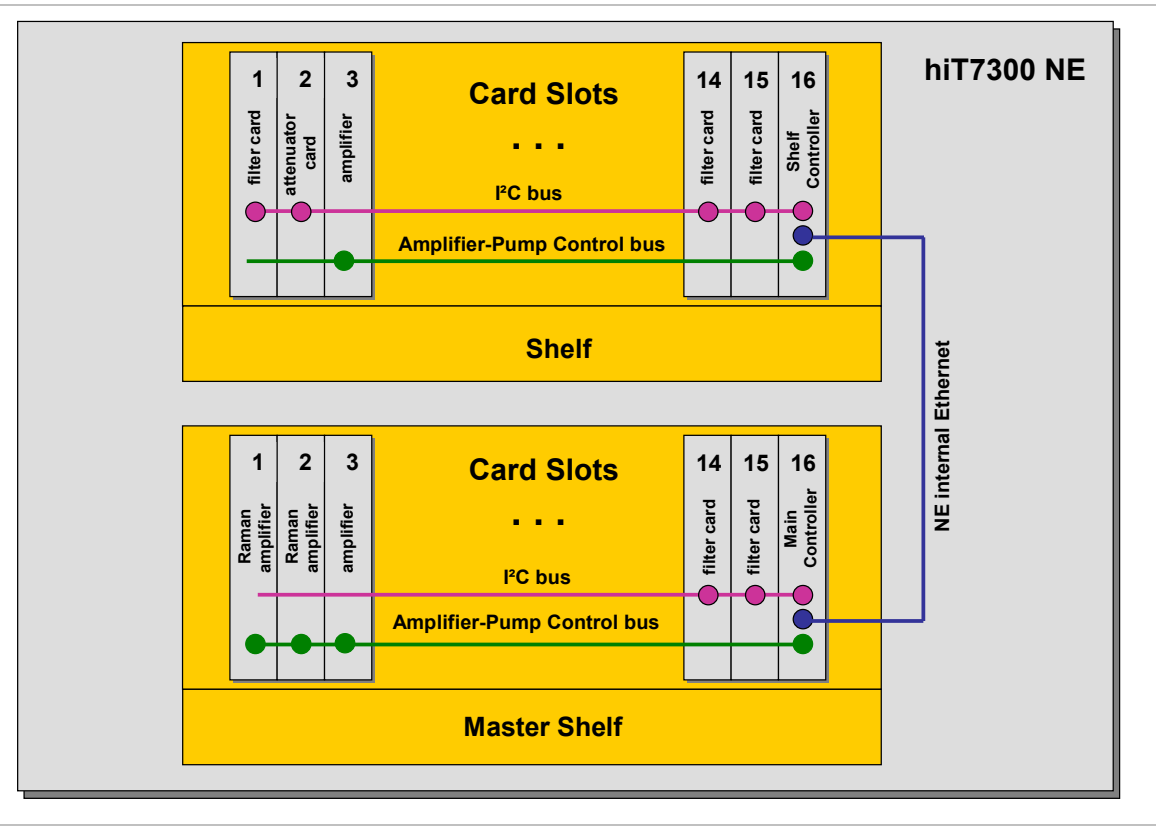

Fig. 94 NE internal communication

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2.7.4 Data Communication Network

The Data Communication Network (DCN) provides TMN access, via Ethernet interfaces Q and QF using SNMPv3, TL1 and HTTP protocols, to all the NE's within one sub-network. The Q interface allows the SURPASS hiT7300 system to be connected to a TMN system, e.g., TNMS. The QF interface has a pre-configured IP address for a direct local connection to the LCT. The LCT obtains its IP address from a DHCP / DNS server on the NE. In addition to the Ethernet interfaces of the NE's, the underlying DCN provides interconnected Data Communication Channels (DCC) to operate all connected NE's.

The services provided by the DCN are:

- Separate the DCN from the customer IP network via NAT-P.
- Software download/distribution via FTP.
- Pre-emphasis and file distribution control based on XML-RPC.
- User channels with point-to-point Ethernet channel per link.
- Time synchronization via Network Time Protocol (NTP).
- Domain Name Service (DNS).
- Dynamic Host Configuration Protocol (DHCP).

The following management protocols are provided by the hiT7300 NE:

SNMP V3	Protocol between NE's and TNMS Core/ TNMS CT/ @CT is used as a direct interface to customer OS
HTTP.1	Used by Web-based LCT - called @CT - and offers a fully functional Element Manager for commissioning or maintenance of a NE.
FTP(S)	Used for file transfer (e.g. PM/alarm data, SW download and etc.)
TL1	Used for Network management acc. Telcordia standards.

2.7.4.1 Gateway Function (GF) of NE

The Gateway Function (GF) provides one single IP address for a sub-network and is the connection point between NE and a network management system. The GF then maps different TCP ports to different NE's with internal IP addresses in this sub-network; implements a Network Address Translation Port forwarding (NAT-P) to hide the DCN internal IP addresses from the carrier data network and a FTP proxy for file transfer between an external FTP server and the NE's. The GF separates the embedded DCN from the customer DCN.

At least two Gateway Functions (GF) should be implemented on different NE's which provides redundant access to the SURPASS hiT7300 DCN.

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The services provided by the DCN are:

- Separate the DCN from the customer IP network via NAT-P.
- Software download/distribution via FTP.
- Pre-emphasis and file distribution control based on XML-RPC.
- User channels with point-to-point Ethernet channel per link.
- Time synchronization via Network Time Protocol (NTP).
- Domain Name Service (DNS).
- Dynamic Host Configuration Protocol (DHCP).

Fig. 95 hiT7300 DCN services

Management protocols are provided by the hiT7300:

SNMP V3	Protocol between NE's and TNMS Core/ TNMS CT/ @CT is used as a direct interface to customer OS
HTTP.1	Used by Web-based LCT - called @CT - and offers a fully functional Element Manager for commissioning or maintenance of a NE.
FTP(S)	Used for file transfer (e.g. PM/alarm data, SW download and etc.)
TL1	Used for Network management acc. Telcordia standards.

Fig. 96 hiT7300management protocols

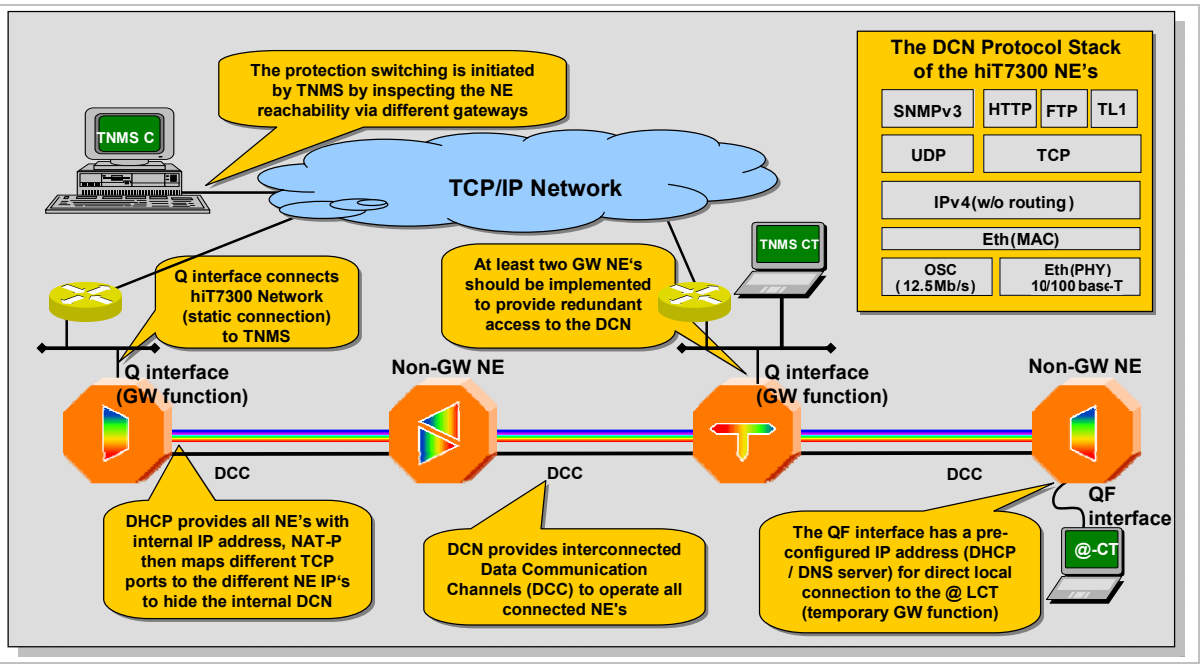
The protection switching is initiated by TNMS by inspecting the NE reachability via different gateways
TNMS C
TCP/IP Network
TNMS CT
Q interface connects hiT7300 Network (static connection) to TNMS
At least two GW NE's should be implemented to provide redundant access to the DCN
Q interface (GW function)
Non-GW NE
Q interface (GW function)
Non-GW NE
DCC
DCC
DCC
QF interface
@-CT
DHCP provides all NE's with internal IP address, NAT-P then maps different TCP ports to the different NE IP's to hide the internal DCN
DCN provides interconnected Data Communication Channels (DCC) to operate all connected NE's
The QF interface has a pre-configured IP address (DHCP / DNS server) for direct local connection to the @ LCT (temporary GW function)
The DCN Protocol Stack of the hiT7300 NE's
SNMPv3
HTTP
FTP
TL1
UDP
TCP
IPv4(w/o routing)
Eth(MAC)
OSC (12.5Mb/s)
Eth(PHY) 10/100 base-T

Fig. 97 hiT7300 Data Communication Network

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The SURPASS hiT7300 DCN network is implemented as a switched network and the Message Communication Function (MCF) is implemented as a L2 switch.

A network of interconnected NE's is designated a DCN domain. The communication is established via the OSC of the optical links and an Ethernet/L2 switching network implemented by the NE's (MCF). A single DCN domain supports up to of 118 NE's.

TIP
To maintain a loop-free topology of a switched DCN network/sub-network, the SURPASS hiT7300 supports the Spanning Tree Protocol (STP).

The connection to the Local Craft Terminal (LCT) and/or the TNMS-C can be done via the Ethernet ports (Q interface) on the CCEP/CCMP controller card. The QF interface has a preconfigured (via DHCP/DNS service) IP address for connecting the LCT. The Q port is normally reserved for the TNMS. If the Q port is used for DCN interconnection with another NE a second IP address can be assigned to the QF port.

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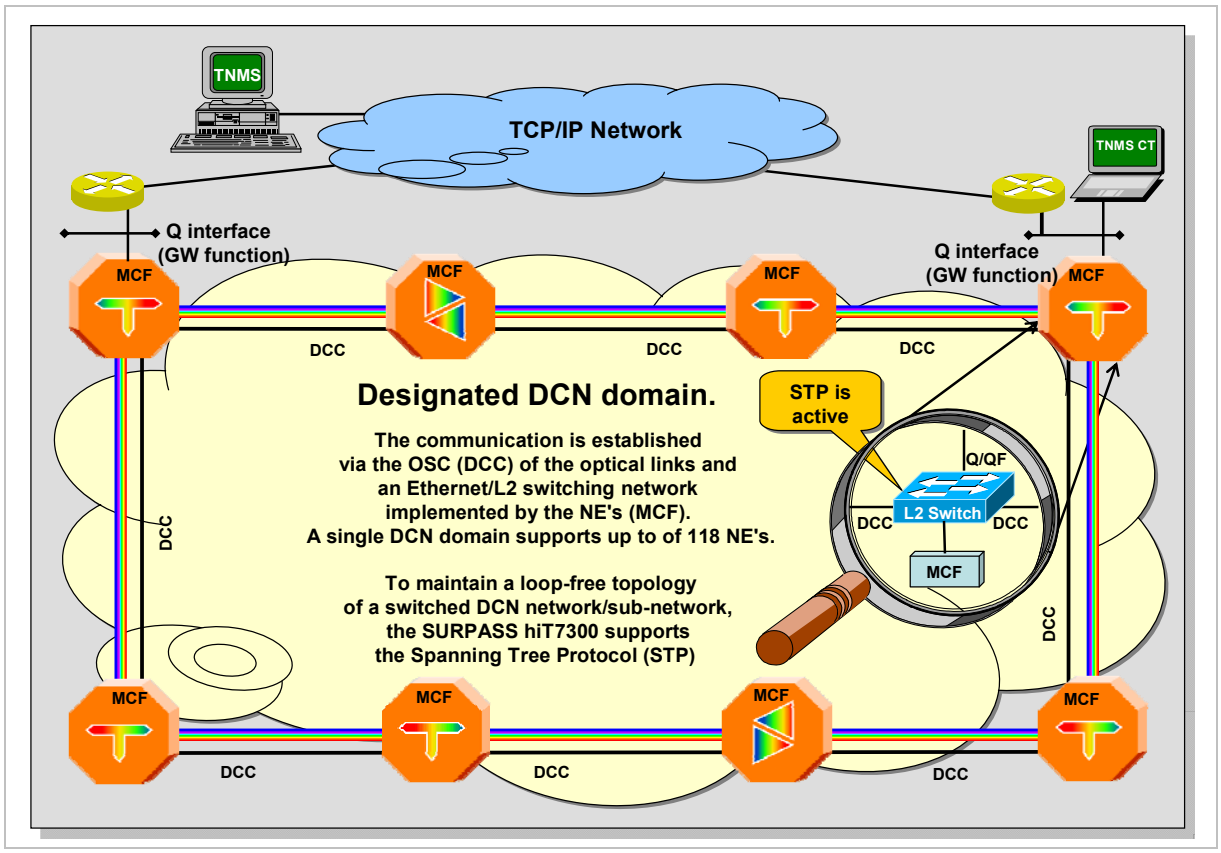

Fig. 98 Data Communication Network

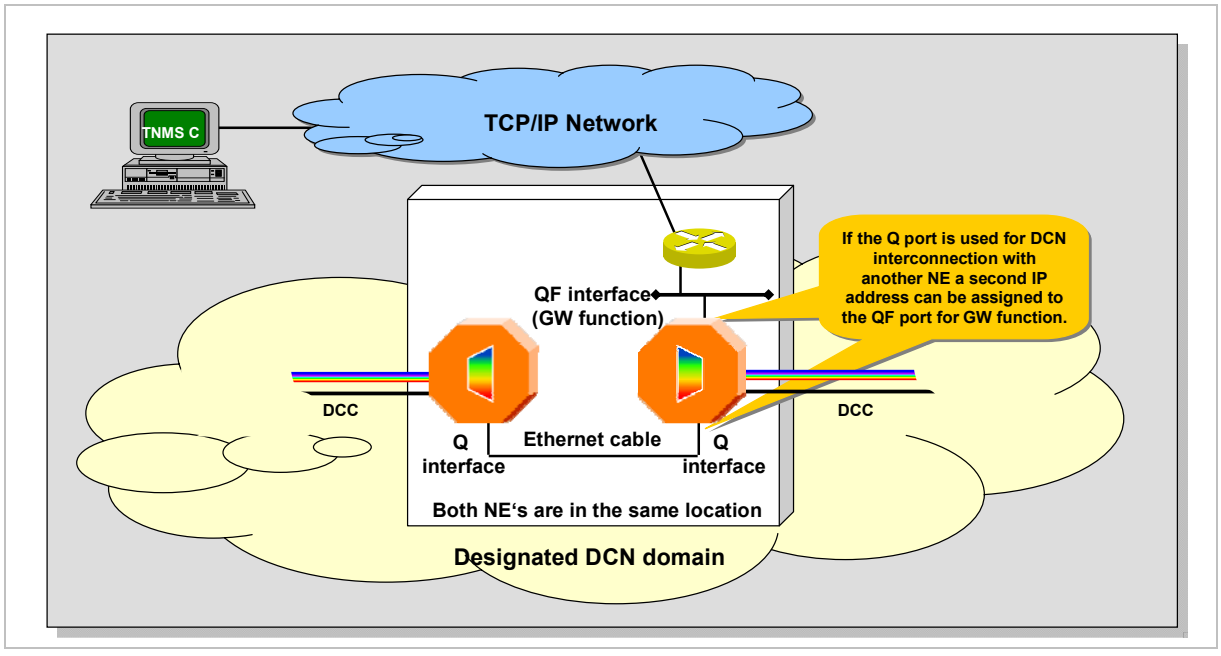

Fig. 99 Usage of the Q port for DCN interconnection

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2.7.4.2 Multi-Domain DCN

A network of interconnected NE's is designated a DCN domain. The communication is established via the OSC of the optical links and an Ethernet/L2 switching network implemented by the NE's (Message Control Function (MCF)).

A single DCN domain supports up to 118 NE's managed via a SNMP TMN system or up to 50 NE's managed via a TL1 TMN system.

The SURPASS hiT 7300 system supports the partitioning of large DCN networks into smaller DCN sub-networks limited between them by border-NEs which allow a separation of L2 switching domains.

Each L2 switching domain has its own gateway NE(s) for communication with the TMN system via the carrier data network. These multi-domain DCN's are characterized by:

- Up to 16 DCN sub-networks, with a maximum of 118 NE's (via SNMP) or 50 NE's (via TL1) per L2 domain can be configured.
- Within an L2 domain the DCN traffic is switched, and at the domain borders all L2broadcast traffic is terminated.
- Border-NE's can connect up to 3 L2 domains.
- Border-NE's can be configured as gateway NE's to provide all the DCN services (e.g., NAT-P, FTP). These services may run in multiple instances to support multiple L2 domains.
- Border-NE's can have distinct NE roles (e.g., primary gateway NE, client DHCP) for each DCN sub-network.
- In-service upgrade from a single to a multi-domain DCN network is possible.
- Optical enhanced pre-emphasis control is also possible for links where both NE's belong to different L2 domains.

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Multi-Domain DCN

- Up to 16 DCN sub-networks, with a maximum of 118 NE's (via SNMP) or 50 NE's (via TL1) per L2 domain can be configured
- Within an L2 domain the DCN traffic is switched, and at the domain borders all L2 broadcast traffic is terminated
- Border-NE's can connect up to 3 L2 domains
- Border-NE's can be configured as gateway NE's to provide all the DCN services (e.g., NAT-P, FTP). These services may run in multiple instances to support multiple L2 domains
- Border-NE's can have distinct NE roles (e.g., primary gateway NE, client DHCP) for each DCN sub-network
- In-service upgrade from a single to a multi-domain DCN network is possible

- Optical enhanced pre-emphasis control is also possible for links where both NE's belong to different L2 domains

Fig. 100

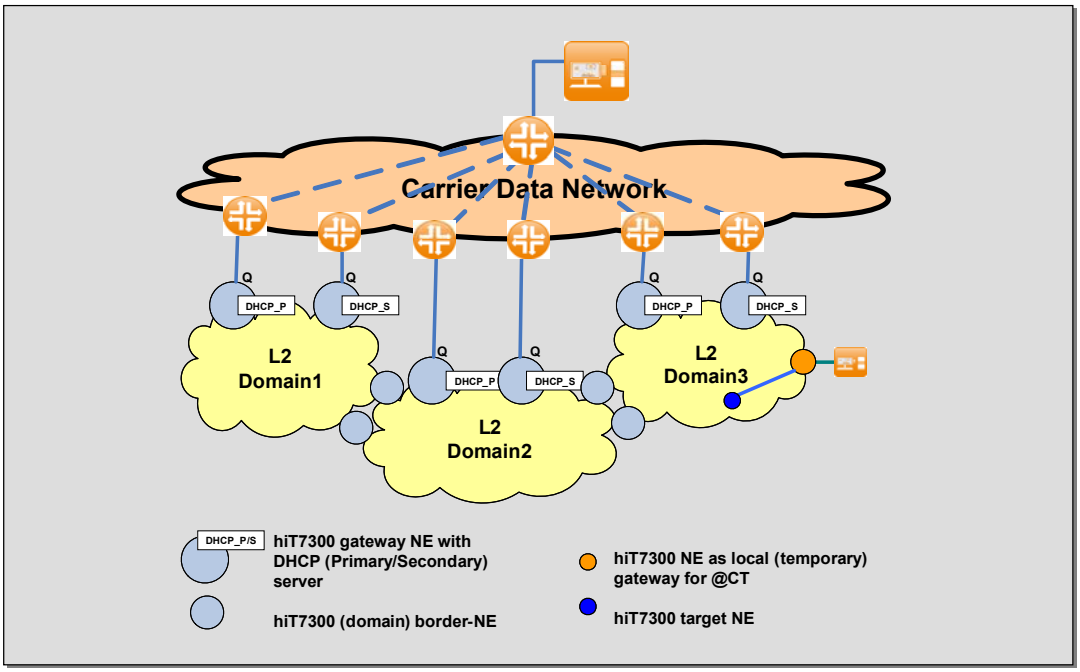

Fig. 101

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2.7.5 Network Time Protocol

The NTP is used for time synchronization of the DCN. When synchronized, all NE's use the same reference clock for time stamping of log entries, issued events, etc. The NE's in the DCN rely on the NE's configured as DHCP servers for time synchronization, i.e., they use the DHCP servers as NTP servers.

The NE's configured as DHCP servers must use external NTP (up to three) servers in the customer network for time synchronization.

The NE chooses the actual NTP server among the available servers, since NTP protocol allows redundant time synchronization.

If no NTP server is available (external or DHCP server), the NE goes into a free-running mode, depending only on its internal clock.

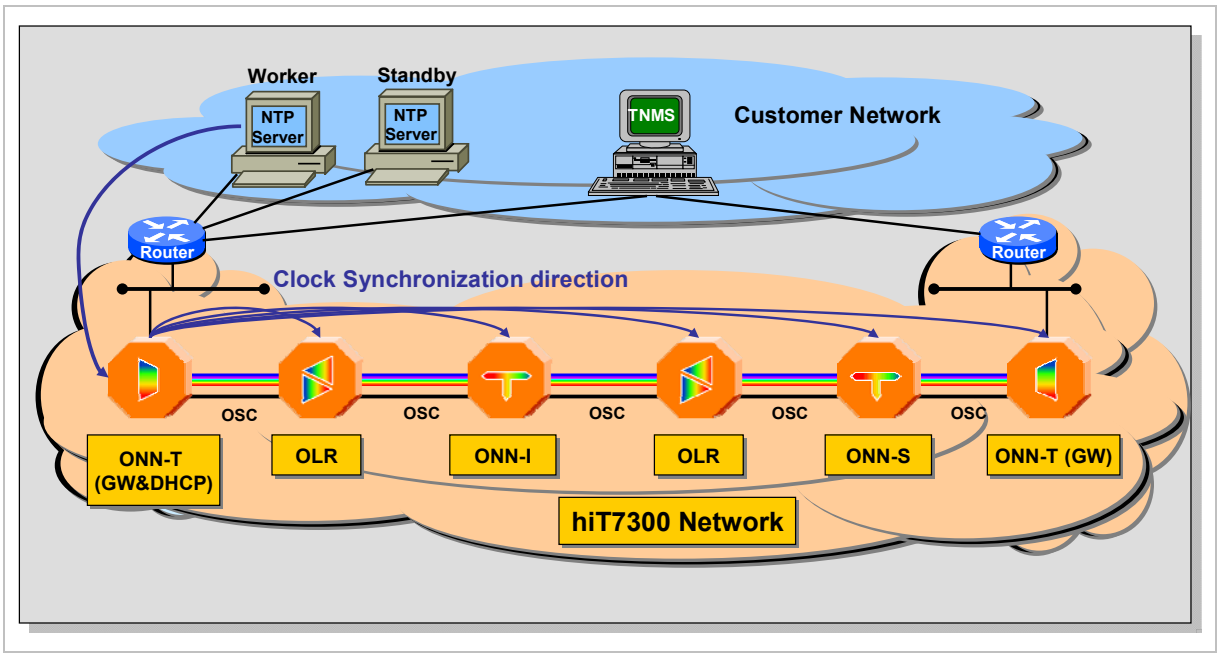

Fig. 102 Network Time Protocol

TIP

In multi-domain topologies, border-NE's which are configured as DHCP clients, obtain time synchronization from all DHCP server NE's (i.e., DHCP servers from all the network domains) by selecting the best reference time.

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2.7.6 Engineering Order Wire interface

The EOW interface can be used to establish conference and selective calls from one NE to other NE(s) using a handset.

When plugged, a handset is automatically in the same conference call of all the other handsets connected to the same line. The communication line is built from all shelves, belonging to different NE's, which are interconnected by OSC's.

In case of a selective call the operator selects an NE by dialing a 3-digit number, which is configured via LCT.

EOW calls are carried over OSC and transmitted together with the OSC payload via the optical fiber along the entire transmission line.

In ring and meshed networks, the line may form a closed ring. A ring manager opens the loop, to prevent the EOW call from feedback distortion.

Inter-shelf EOW connection in multi-degree ONN's is achieved with a 4-wire cable that interconnects the controller cards of different shelves belonging to the same NE. This allows EOW calls in interconnected rings and meshed networks

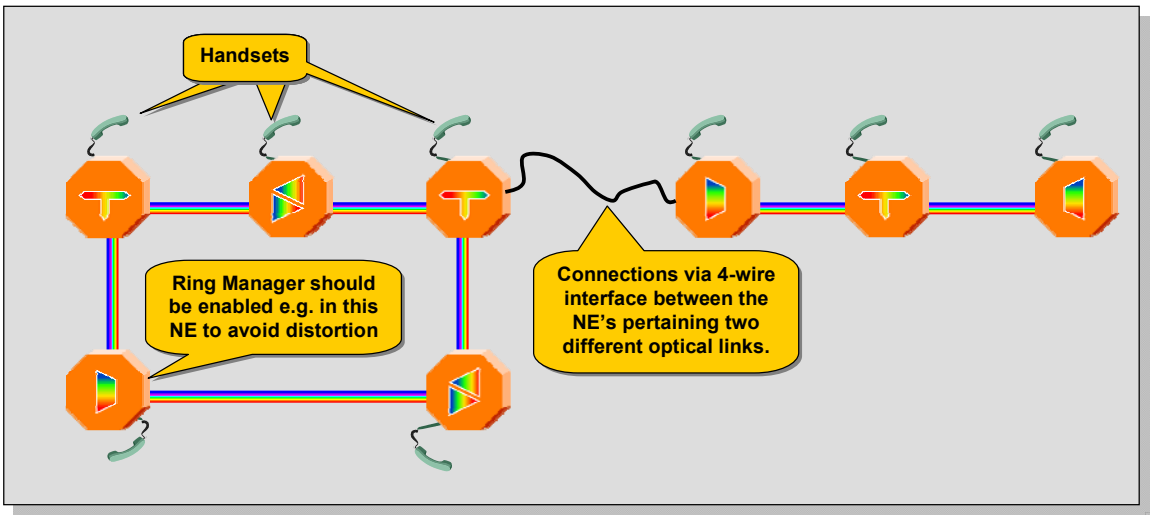
Handsets
Ring Manager should be enabled e.g. in this NE to avoid distortion
Connections via 4-wire interface between the NE's pertaining two different optical links.

Fig. 103 Engineering Order Wire interface

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2.7.7 User channels

The SURPASS hiT 7300 user channels (each 10 Mbit/s) are used for bidirectional connections between NE's via the OSC or GCC0, providing the customer with a point-to-point Ethernet connection for specific data network or remote access to NE's not reachable via DCN. The user channels are accessible via two Ethernet ports, User 1 and User 2.

Up to two user channels (belonging to different spans) can be terminated on each controller card. If both user channels belong to the same span only one user channel can be terminated. Transit user channels (i.e., transfer traffic routed to another span) are forwarded to the respective span by the NE shelf controller.

The actual number of user channels that can be used in an NE depends on the number of transponders and line amplifier cards configured with OTU-k. Per NE a maximum of 26 GCC0 channels and 8 OSC channels is supported, each carrying two user channels.

In ONN's, the user channels are terminated by default. However, they can be set to through connected via LCT (within the same controller card) or by interconnecting the User 1/User 2 connectors (of different controller cards) via an Ethernet cable. In OLR's, the user channels are through connected by default. Using LCT, the through connection can be opened and the user channels are accessible at OLR's also.

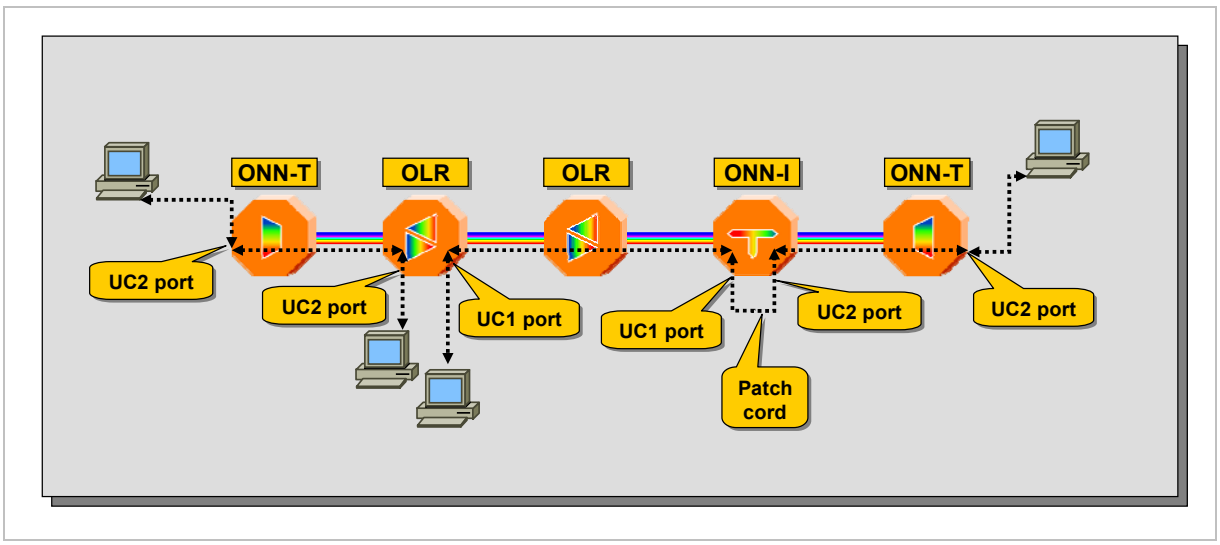

Fig. 104 User channels

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2.7.8 Telemetry Interface

The TIF sensors (inputs) and TIF actors (outputs) are intended to be used for traditional user-defined “housekeeping” purposes. The TIF sensors usually supervise particular events at the site (e.g., fire alarm, over-temperature alarm, door-open alarm, etc.) and carry alarms issued by external equipment (e.g., StrataLight OTS-4000 and MPBC RMH07 series). The TIF actors usually control particular devices at the site (e.g., lights, air conditioning, etc.).

TIF sensors and actors are available on the first shelf (001) of the CCEP-1 controller card with 16 sensors and 15 actors. Actors, 1 to 8, are free to be used by the user. The remaining actors, 9 to 15, are used for equipment/communication alarm indication purposes, visible and audible. The TIF sensors generate an environmental alarm on the NE, when the current state differs from the configurable normal state.

TIF actors	Description
TIF Actors, 1 to 8	Free to be used by the user
TIF actor 9	Critical Alarms (audible)
TIF actor 10	Major Alarms (audible)
TIF actor 11	Minor Alarms (audible)
TIF actor 12	Critical Alarms (visible)
TIF actor 13	Major Alarms (visible)
TIF actor 14	Minor Alarms (visible)
TIF actor 15	Power Equipment Alarm

TIF sensors and actors are available on the CCEP-1 controller card with 16 sensors and 15 actors; TIF sensors supervise events and TIF actors control devices. TIF actors can be used as follow:

TIF actors	Description
TIF Actors, 1 to 8	Free to be used by the user
TIF actor 9	Critical Alarms (audible)
TIF actor 10	Major Alarms (audible)
TIF actor 11	Minor Alarms (audible)
TIF actor 12	Critical Alarms (visible)
TIF actor 13	Major Alarms (visible)
TIF actor 14	Minor Alarms (visible)
TIF actor 15	Power Equipment Alarm

Fig. 105 TIF Actors

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2.7.9 Controller Cards functions

Each shelf is to be equipped with a controller card at a dedicated slot position. There is always one main shelf which includes the NE controller and there can be several extension shelves which have a shelf controller. The controller cards act as a NE controller on the main shelf and the sub-shelves, mainly providing NE central interfaces and functions.

The Controller cards provide the central monitoring and control functions for the system, as well as the MCF to operate the Q and QF communication interfaces. Using these interfaces, the Controller card performs the following main functions:

- Fault Management:
  Monitoring all system alarms and forwarding their states to the network management system.
- Performance Management:
  On request, sending all optical performance management information to the network management system and/or a craft terminal.
- Configuration Management:
  Configuring the system to either default settings or to persistently stored settings initiated by the network management system and/or a craft terminal.
- Security Management:
  Controlling the individual access via the network management system and/or a craft terminal to particular NE functions, using a hierarchical security management user ID and password concept.
- Equipment Management:
  Monitoring the actual and required shelf equipping.
- Communication Management:
  Implementing the MCF for the communication between all NE's and the network management system.
- Software Management:
  Performing all software downloads, uploads, and software integrity functions.
- Real Time Management:
  Controlling the real-time clock.
- Providing alarm outputs from shelves and racks.
- Controlling the NE alarm LED's (e.g., major/minor, for communication and equipment alarms).

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Controller card performs the following main functions:

- **Fault Management:** Monitoring all system alarms and forwarding their states to the network management system.
- **Performance Management:** On request, sending all optical performance management information to the network management system and / or a craft terminal.
- **Configuration Management:** Configuring the system to either default settings or to persistently stored settings initiated by the network management system and/or a craft terminal.
- **Security Management:** Controlling the individual access via the network management system and/or a craft terminal to particular NE functions, using a hierarchical security management user ID and password concept.
- **Equipment Management:** Monitoring the actual and required shelf equipping.
- **Software Management:** Performing all software downloads, uploads, and software integrity functions.
- **Real Time Management:** Controlling the real-time clock.
- Providing alarm outputs from shelves and racks.
- Controlling the NE alarm LED's (e.g., major/minor, for communication and equipment alarms).

Fig. 106 Controller cards main functions

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2.7.10 Controller Cards types

Three types of controller cards are available as described below:

- CCEP-1, NE and main shelf controller card with TIF/Alarm interfaces;
- CCEP-2, NE and main shelf controller card with TIF/Alarm interfaces; necessary for GMPLS
- CCMP-1, NE and main shelf controller card without TIF/Alarm interfaces;
- CCMP-1, NE and main shelf controller card without TIF/Alarm interfaces; necessary for GMPLS
- CCSP-1, extension shelf controller card.

The CCEP and CCMP controller cards consist of the same controller card motherboard, where only the CCEP includes an additional module for TIF/Alarm interfaces. Both CCEP and CCMP can be equipped in the main shelf for operation as the NE controller card and providing the external management interfaces (Q, QF) of the NE.

The CCSP card is equipped in each extension shelf of the hiT7300. The front plate of the CCSP card looks exactly as the CCMP card except that it has eliminated all the redundant functions (e.g. Q, QF interface) that are already available in the main controller card (CCEP/CCMP). This results in reduction of component and power supply requirement sufficient for management of an extension shelf.

The following table explains the external interfaces provided on the front panel of the controller cards:

Label on card	Physical I/F	Function
Fault	LED (red)	Fault indication of controller
OK	LED (green)	Service status of controller
UBAT 1 to 4	LED (green)	Shelf power supervision
COM-AL (CRIT, MAJ, MIN)	LED (red, orange, yellow)	Communication alarm status
EQUIP-AL (CRIT, MAJ, MIN)	LED (red, orange, yellow)	Equipment alarm status
INFO	LED (green / red)	General Purpose Indication
RJ22 ---	4-pin RJ22 connector	Handset connector
EOW	D-SUB9 connector	EOW shelf interconnection
USER 1 / USER 2	10/100BaseT, RJ45 connector	User channel 1 & 2 (point to point user channel connection)
ILAN 1 / ILAN 2	10/100BaseT, RJ45 connector	Internal LAN shelf connection 1 & 2 (connection between shelves)

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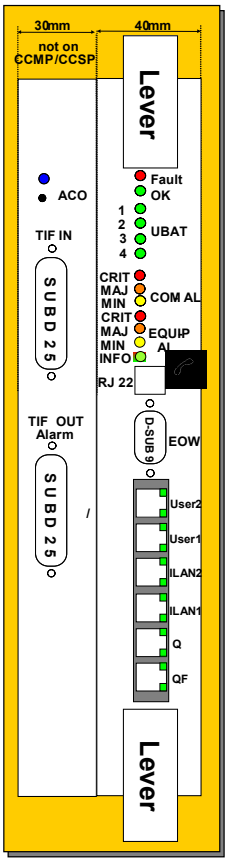

Label on card	Physical I/F	Function
Fault	LED (red)	Fault indication of controller
OK	LED (green)	Service status of controller
UBAT 1 to 4	LED (green)	Shelf power supervision
COM-AL (CRIT, MAJ, MIN)	LED (red, orange, yellow)	Communication alarm status
EQUIP-AL (CRIT, MAJ, MIN)	LED (red, orange, yellow)	Equipment alarm status
INFO	LED (green / red)	General Purpose Indication
RJ22 ---	4-pin RJ22 connector	Handset connector
EOW	D-SUB9 connector	EOW shelf interconnection
USER 1 / USER 2	10/100BaseT, RJ45 connector	User channel 1 & 2 (point to point user channel connection)
ILAN 1 / ILAN 2	10/100BaseT, RJ45 connector	Internal LAN shelf connection 1 & 2 (connection between shelves)
Q	10/100BaseT, RJ45 connector	Management Interface (not usable on CCSP)
QF	10/100BaseT, RJ45 connector	Management Interface (not usable on CCSP)
ACO	LED (blue)	Alarm Acknowledge Indication
ACO	button	Manual Alarm Acknowledge
TIFIN	16 TIF inputs, D-SUB25 connector	Telemetry Interface Inputs
TIFOUT / Alarm	8 TIF outputs + 6 outputs for TIF or external alarms + 1 power alarm output, D-SUB25 connector	Telemetry Interface Outputs, TIF or External Station Alarms (audible/visible), External Power Alarm

Fig. 107

Label on card	Physical I/F	Function
Q	10/100BaseT, RJ45 connector	Management Interface (not usable on CCSP)
QF	10/100BaseT, RJ45 connector	Management Interface (not usable on CCSP)
ACO	LED (blue)	Alarm Acknowledge Indication
ACO	button	Manual Alarm Acknowledge
TIFIN	16 TIF inputs, D-SUB25 connector	Telemetry Interface Inputs
TIFOUT / Alarm	8 TIF outputs + 6 outputs for TIF or external alarms + 1 power alarm output, D-SUB25 connector	Telemetry Interface Outputs, TIF or External Station Alarms (audible/visible), External Power Alarm

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Controller Cards

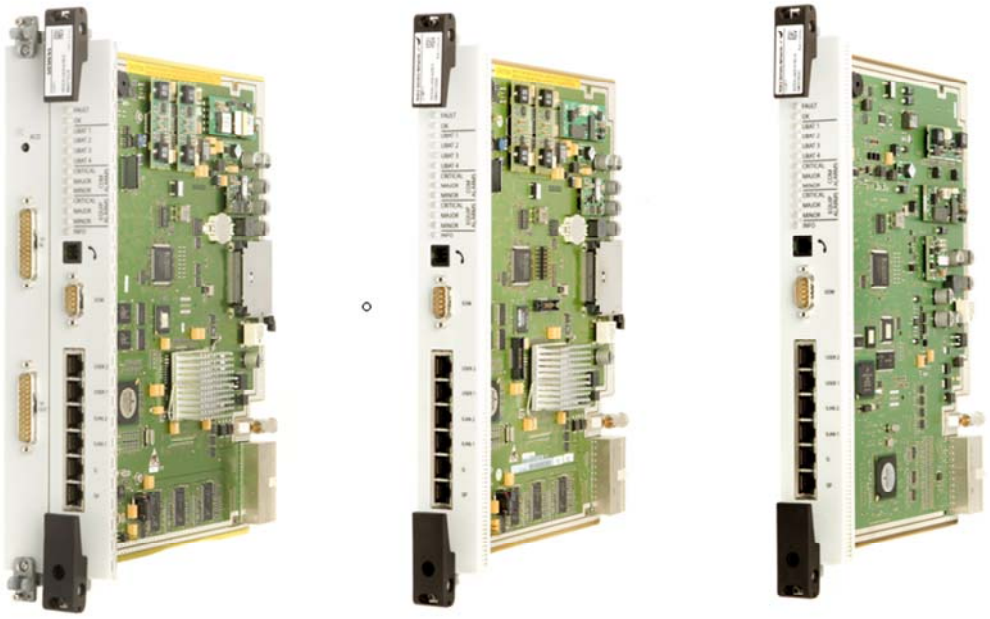

Fig. 108 Controller Cards

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2.7.11 Scalable multi-controller architecture

hiT 7300 introduces a multi-controller architecture where the subagent controllers completely handle the controlled sub NE which improves performance of processing power intensive applications (e.g. optical GMPLS), as well as start-up performance. It ensures scalability of a network element (NE) when upgrading networks or introducing new functionality.

The multi-controller architecture distributes the total workload among several subsystem controller cards (CCEP/CCMP). One subsystem controller, known as the 'master agent', takes the role of the NE controller, provides management interfaces to the network and delegates tasks to the other controller cards. The other controller cards, known as 'subagents' - are only internally used in the NE, with each being responsible for a different set of shelves. The subagents only manage those cards assigned to the subsystem and perform tasks such as equipment management or performance monitoring.

Existing NE's can be migrated from single-controller to multi-controller architectures and support both options. The new ONN-X96 MD-ROADM requires a multi-controller architecture, due to its large number of supported channels and degrees.

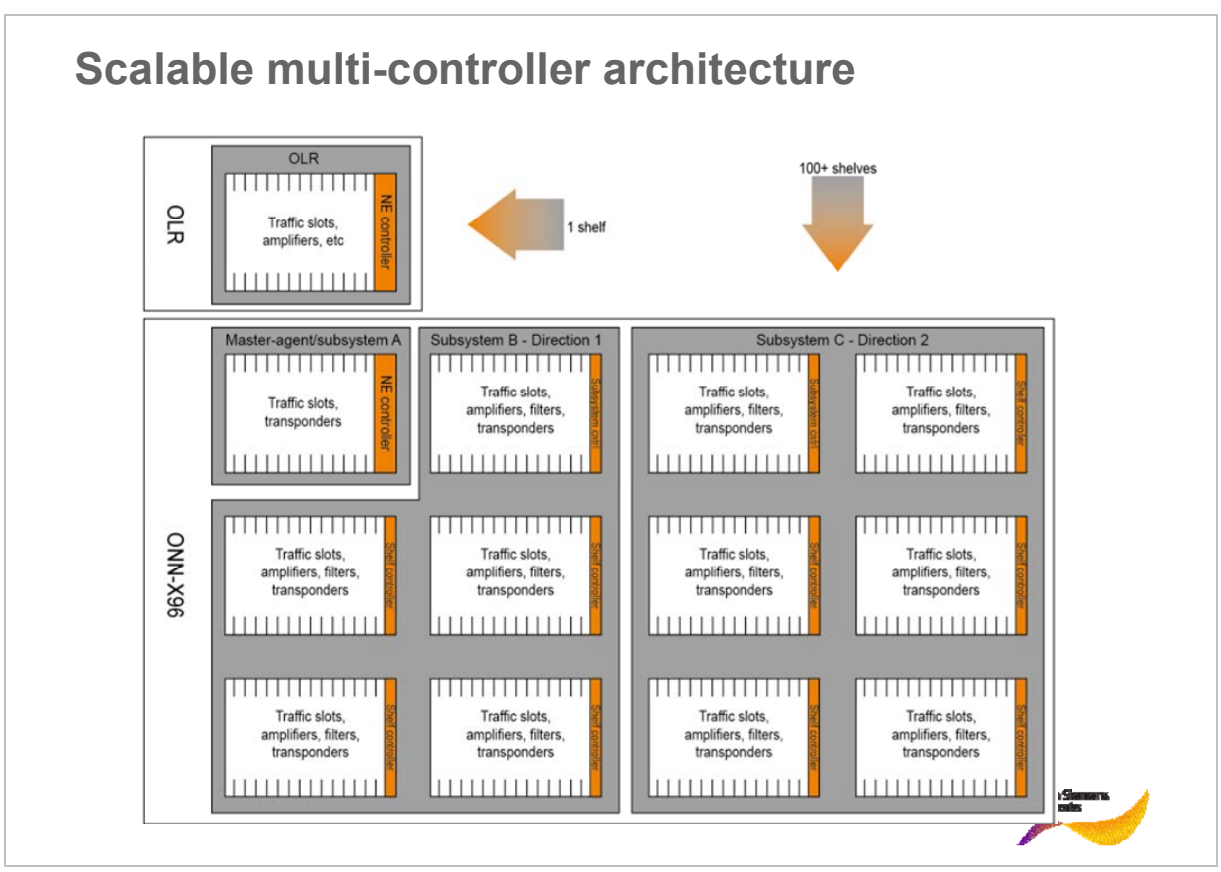

Fig. 109

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2.7.12 Optical Attenuator cards

SURPASS hiT7300 provides the O08VA-1 card as variable optical attenuator card for 8 unidirectional channels. Variable attenuators (VOA's) can be used for dynamic power adjustment as pre- and/or de-emphasis per optical channel or per subband.

Following table shows the technical parameters of O08VA-1 card.

O08VA-1 Technical Data	
Attenuation range	0-22 dB
Operating Band	1528-1610 nm
Maximum Insertion loss	1.5 dB
Resolution	0.1 dB per step
Response time	10 ms
Power Handling per VOA channel	< 21 dBm

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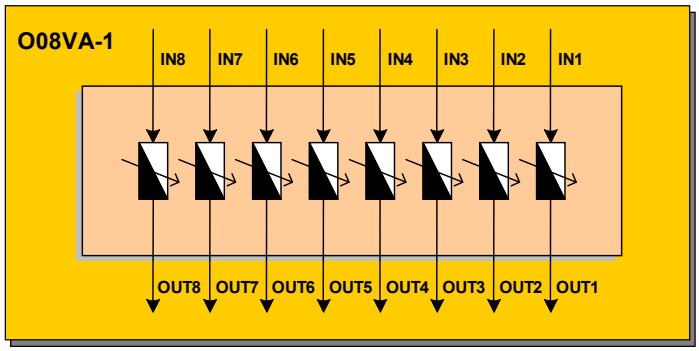

O08VA-1·Technical·Data¤	
Attenuation·range¤	0-22·dB¤
Operating·Band¤	1528-1610·nm¤
Maximum·Insertion·loss¤	1.5·dB¤
Resolution¤	0.1·dB·per·step¤
Response·time¤	10·ms¤
Power·Handling·per·VOA·channel¤	<·21·dBm¤

Fig. 110 Optical Attenuator card

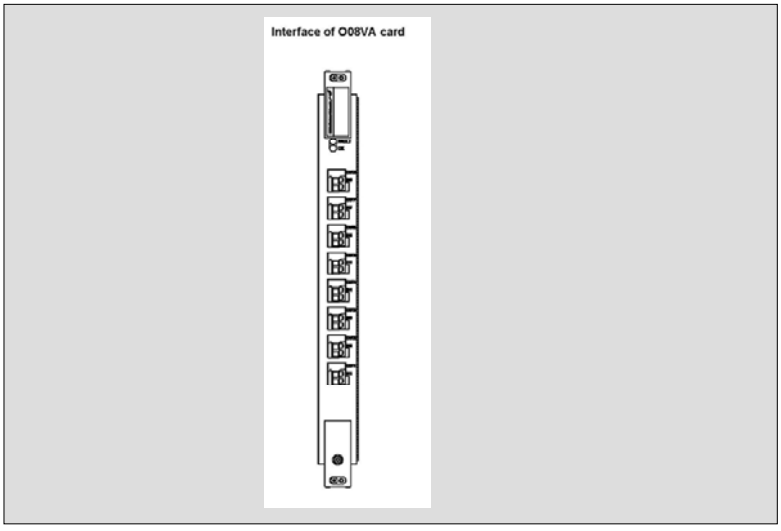

Fig. 111 HW layout

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2.7.13 Channel power monitor (MCP4x-x) card

The channel power monitor card MCP4x-x provides an in-service monitoring of the optical channel power levels. The card contains an Optical Spectrum Analyzer (OSA) for 40/80 channels, which is periodically connected to 4 optical input ports.

There is three different types of the channel power monitor card are available:

Card name	Supported bit rates	Usage
MCP404-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP404-2	2.5 Gbit/s; 10 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP4-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	80 channels (within 50 GHz grid) monitoring

The MCP4x-x card is used for:

- In-service measurement of optical channel power levels of the 40 channels on a 100 GHz grid at the source monitoring output port which is used for all optical amplifier card types as well as for the OSC termination card (LIFB-1).
- Measurement of an automated enhanced pre-emphasis configuration on an optical pre-emphasis section (i.e., a link with full channel multiplexing/demultiplexing). Using MCP4xx-x card at the beginning and end of a link in combination with an attenuator card, provides a fully automated optical link commissioning and an in service channel upgrade.
- Measurement of an automatic in-service amplifier tilt control. Using MCP4xx-x card at the beginning and end of a link, allows tilt correction values to be distributed over the whole link.
- Automatic performance measurement and supervision of optical carriers with autonomous start of measurement cycle every 300 seconds.

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There is three different types of the channel power monitor card are available:

Card name	Supported bit rates	Usage
MCP404-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP404-2	2.5 Gbit/s; 10 Gbit/s	40 channels (within 100 GHz grid) monitoring
MCP4-1	2.5 Gbit/s; 10 Gbit/s; 40 Gbit/s	80 channels (within 50 GHz grid) monitoring

The MCP4x-x card is used for:

- **In-service measurement of optical channel power levels of all channels**
- **Measurement of an automated enhanced pre-emphasis configuration**
- **Measurement of an automatic in-service amplifier tilt control**
- **Automatic performance measurement and supervision of optical carriers**

Fig. 112

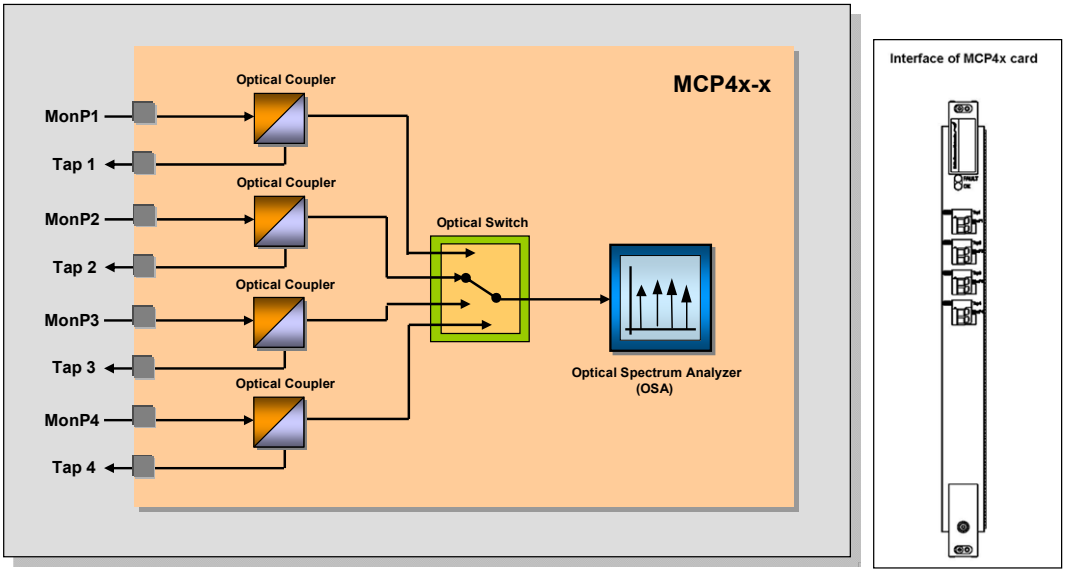

Fig. 113 Channel power monitor (MCP4x-x) card

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2.7.14 Optical Transient Suppression Card (OTSC)

In addition, a new Optical Transient Suppression for C-band card (OTSC-1) is introduced. It provides Transient Suppression Channels (TSCh), which are permanently powered to prevent the build up of transients and can instantaneously replace power of dropped channels if most of the transmission channels are lost. The OTSC-1 placement is a good choice when the customer has extremely rigid requirements on transient behavior. If there are no specific requirements, the transient performance of hiT 7300 without OTSC-1 is sufficient.

The advantage of the OTSC-1 is that it allows the reduction of the planned transient margin in the link design, thus improving reach and lowering cost of the hardware. Additionally it can be added to any existing link to improve transient tolerance, without any other change of hardware required. The card offers the following functionality:

- 96 channel spectral range, suitable for DCM-free networks with 40G/100G CP-QPSK technology
- Transient protection for up to 80 traffic channels within the 96 channel plan
- 6 channels used for transient suppression channels, each with 2 x polarization multiplexed lasers (these channels are blocked for transmission – in addition, immediate adjacent channels are blocked as well, to optimize transient protection)
- 2 transient cards needed for each bi-directional Optical Multiplex Section (OMS) of the network (the transient channels are coupled in before the booster amplifier and blocked at the end of the OMS by the WSS)
- Enhanced transient performance of up to 10dB drops within 100ms

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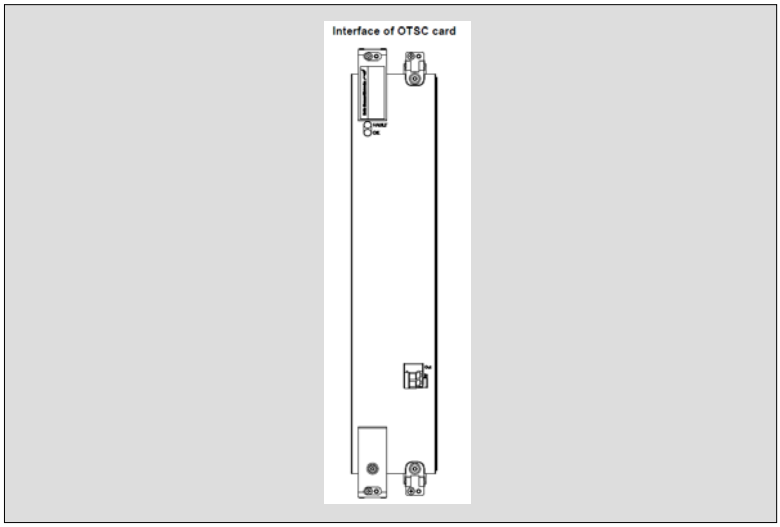

Fig. 114 HW layout

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2.7.15 Flow Sensor Card (CFSU)

The CFSU card serves as a flow sensor unit to supervise the hiT 7300 shelf on sufficient air flow. The CFSU measures the amount of air flow through the shelf by also taking the absolute air pressure and the air temperature into consideration.

The CSFU card is an optional card which is useful in particular if a NE is installed within dusty environments in order to give an early indication on insufficient air flow due to a clogged dust filter within a hiT 7300 shelf. In order to ensure reliable measurement of the air flow, the CFSU card must be used in the high flow region of the fan to ensure maximum airflow conditions, for this purpose the card must always be plugged within slot #1 (left-most slot of a hiT 7300 shelf) and the right hand neighbor slot must not be empty.

The CFSU card included the following integrated sensors:

- Air flow sensor;
- Absolute air pressure sensor;
- Temperature sensor.

The CFSU card is optimized for the specific air filter media used in hiT 7300 standard shelf.

When the air flow is below a specific level this condition is alarmed so that the dust filter mat within the fan unit (CFS) of the hiT 7300 shelf should be replaced. Additionally there is a timer so that the filter mat is replaced after 6 up to 18 months of use anyway. At each cycle of determining the dust contamination of the dust filter mat all fans within the CFS fan tray are accelerated to top speed for 3 minutes and released to their normal operating speed afterwards. The time interval between each measurement cycle is configurable from 1 to 255 hours in steps of 1 hour.

At the front panel of the CFSU card there are 3 LED's for signaling different conditions and a button for restarting the 12 month timer.

- A red LED signals that a fault has occurred (CFSU card problem);
- A green LED signals faultless operation;
- A yellow LED signals that the dust filter mat has to be replaced;

TIP
The restart button causes a restart of the 12 month timer when pressed for more than 5s.

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Flow Sensor Card (CFSU)

- The CFSU card measures the amount of air flow through the shelf;
- The CSFU card is useful in particular if a NE is installed within dusty environments;
- The CFSU card included the following integrated sensors:
  - Air flow sensor;
  - Absolute air pressure sensor;
  - Temperature sensor.
- The CFSU card has a timer so that the filter mat is replaced after 6 up to 18 months of use anyway;
- CFSU card can also be used for management of dispersion compensation modules, which are plugged within external DCM shelves;

Fig. 115

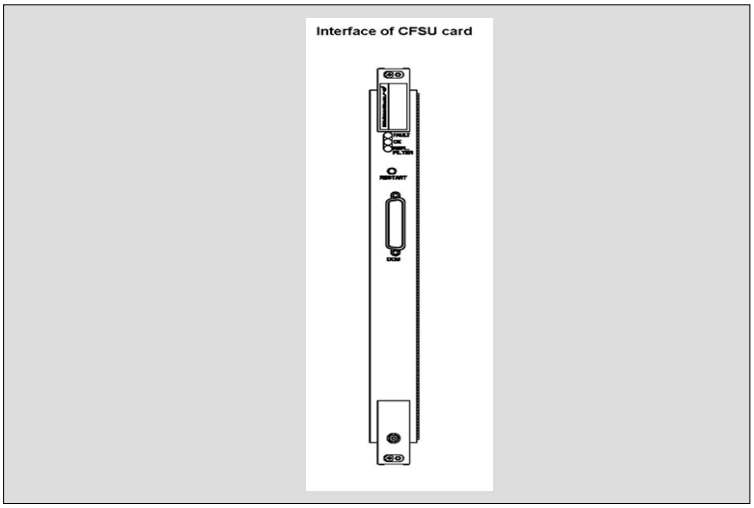

Fig. 116 FSC

In addition to air flow supervision, the CFSU card can also be used for management of dispersion compensation modules which are plugged within external DCM shelves and therefore do not have a direct internal management interface to the NE controller (CCxP) of a NE. For this purpose the CFSU card provides a front panel connector (SUBD) for an electrical SPI interface which can optionally be connected to an external DCM shelf for access of up to 4 plugged dispersion compensation modules, which can then be managed by the NE controller.

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2.7.16 Dispersion Module Management Card (CDMM)

The CDMM card can optionally be used for management of dispersion compensation modules which are plugged within external DCM shelves and therefore do not have a direct internal management interface to the NE controller (CCxP) of a NE. For this purpose the CDMM card provides a front panel connector (SUBD) for an electrical SPI interface which can optionally be connected to an external DCM shelf for access of up to 4 plugged dispersion compensation modules, which can then be managed by the NE controller.

The CDMM card can be used within any slot of a hiT 7300 standard shelf or a hiT 7300 flatpack shelf. The CDMM card occupies 1 slot (30mm).

Dispersion Module Management Card (CDMM)

- **The CDMM card is used for management of dispersion compensation modules, which are plugged within external DCM shelves, where up to 4 plugged dispersion compensation modules can be managed by the NE controller .**
- **CDMM card provides a front panel connector (SUBD) for an electrical SPI interface.**
- **The CDMM card can be used within any slot of a hiT 7300 standard shelf or a hiT 7300 flatpack shelf.**
- **The CDMM card occupies 1 slot.**

Fig. 117

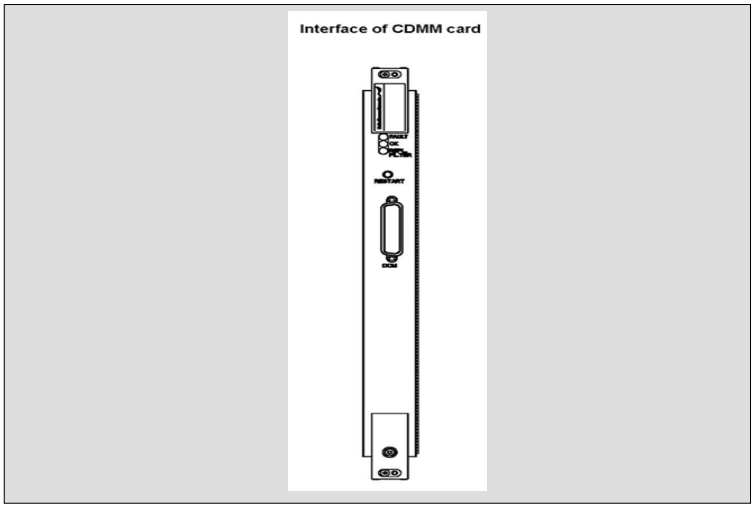

Fig. 118 CDMM Card

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3 SURPASS hiT7300 NE Types

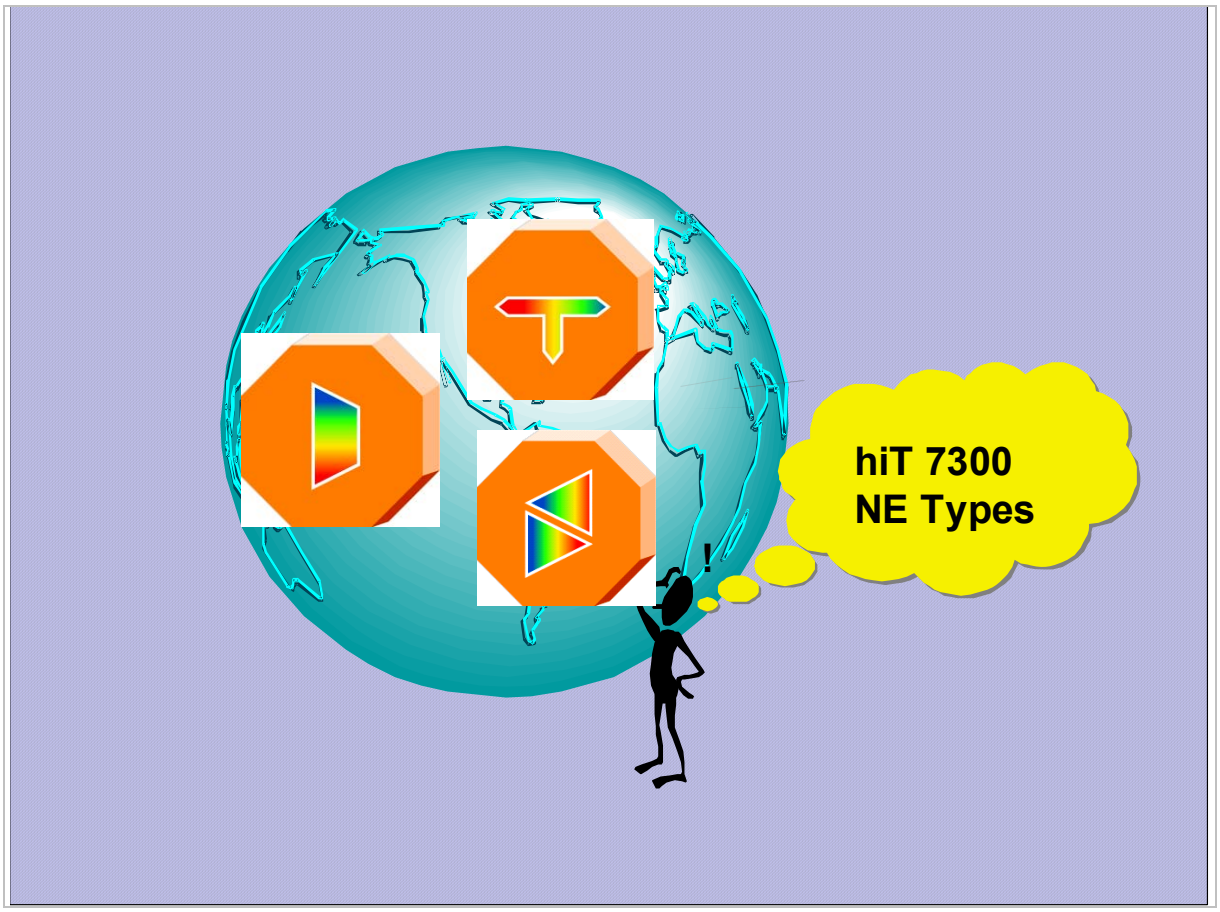

Fig. 119 NE Types

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SURPASS hiT7300 offers three basic Network Element Types which are:

- OLR – Optical Line Repeater;
- ONN – Optical Network Node;
- SON (SONF)– Standalone Optical Node.(Flatpack)

The following table lists all SURPASS hiT7300 available NE's types:

NE	Subtype	Description
OLR	n.a.	Optical Line Repeater Used for optical signal amplification with dispersion compensation. Terminates 2 spans.
ONN	ONN-T (80)	Optical termination node for realization of a Terminal 1/2 OADM with up to 40 (80) channels. Used for amplification, dispersion compensation, and full add/drop within an optical path.
	ONN-I (80)	Optical interconnection node for realization of a FullAccess OADM or Flexible OADM with up to 40 (80) channels. Used for amplification, dispersion compensation, and full add/drop.
	ONN-R (80)	Optical interconnection node for realization of a FullAccess OADM or Reconfigurable OADM (ROADM) with up to 40 (80) channels. Used for amplification, dispersion compensation, and partial or full add/drop.
	ONN-R2	Cost optimized ROADM for 2 degree ONN with EOL 40 channel capacity. Used for amplification, dispersion compensation, and partial or full add/drop.
	ONN-RT (80)	Tunable ROADM for 40 (80) channels. It has a limited add drop capacity of 8 ch @ EOL 40 or 16 ch @ EOL 80 channels.
	ONN-S	Optical interconnection node for realization of Small OADM. Used for amplification, dispersion compensation, and partial add/drop within a link.
	ONN-X (80)	Optical interconnection node for realization of a **PXC** with up to 40 (80) channels. Used for amplification, dispersion compensation, and partial or full add/drop.
	ONN-X96	Optical cross connect for 96 channels using DCM free network technology.
SON	SON SONF	Standalone Optical Node used for: Passive optical multiplexing/demultiplexing optionally combined with transponder application. Pure transponder application. Long single span transmission by inter-working with RMH07, 1RU, and 2RU series from MPBC.

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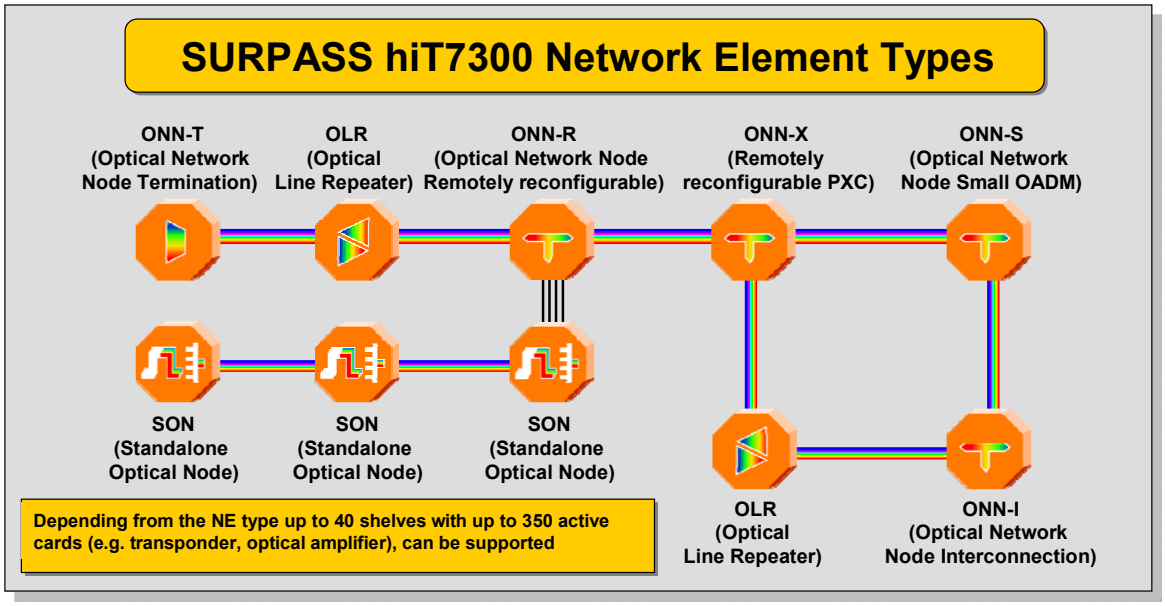
SURPASS hiT7300 Network Element Types
ONN-T (Optical Network Node Termination)
OLR (Optical Line Repeater)
ONN-R (Optical Network Node Remotely reconfigurable)
ONN-X (Remotely reconfigurable PXC)
ONN-S (Optical Network Node Small OADM)
SON (Standalone Optical Node)
SON (Standalone Optical Node)
SON (Standalone Optical Node)
OLR (Optical Line Repeater)
ONN-I (Optical Network Node Interconnection)
Depending from the NE type up to 40 shelves with up to 350 active cards (e.g. transponder, optical amplifier), can be supported

Fig. 120 SURPASS hiT7300 Network Element Types_1

NE	Subtype	Description
OLR	n.a.	Optical Line Repeater Used for optical signal amplification with dispersion compensation. Terminates 2 spans.
ONN	ONN-T (80)	Optical termination node for realization of a **Terminal** 1/2 OADM with up to 40 (80) channels. Used for amplification, dispersion compensation, and full add/drop within an optical path.
	ONN-I (80)	Optical interconnection node for realization of a **FullAccess OADM** or Flexible OADM with up to 40 (80) channels. Used for amplification, dispersion compensation, and full add/drop.
	ONN-R (80)	Optical interconnection node for realization of a **FullAccess OADM** or **Reconfigurable OADM (ROADM)** with up to 40 (80) channels. Used for amplification, dispersion compensation, and partial or full add/drop.
	ONN-R2	Cost optimized **ROADM for 2 degree** ONN with EOL 40 channel capacity. Used for amplification, dispersion compensation, and partial or full add/drop.
	ONN-RT (80)	**Tunable ROADM** for 40 (80) channels. It has a limited add drop capacity of 8 ch @ EOL 40 or 16 ch @ EOL 80 channels.
	ONN-S	Optical interconnection node for realization of **Small OADM**. Used for amplification, dispersion compensation, and partial add/drop within a link.
	ONN-X (80 / 96)	Optical interconnection node for realization of a **PXC** with up to 40 (80) channels. Used for amplification, dispersion compensation, and partial or full add/drop.
SON	SON SONF	**Standalone Optical Node** used for: Passive optical multiplexing/demultiplexing optionally combined with transponder application. Pure transponder application. Long single span transmission by inter-working with RMH07, 1RU, and 2RU series from MPBC.

Fig. 121 SURPASS hiT7300 Network Element Types_2

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3.1 Optical Line Repeater (OLR) Network Element

The OLR is a DWDM NE which supports:

- The following card types:
  – Controller cards
  – Inline amplifier cards
  – External pump cards
  – Dispersion compensation module cards
- Raman amplification together with one line amplifier card.
- Two bidirectional OSC terminations within a single shelf.
- Power reduction to class 1M (APSD) for laser safety on line, with and without Raman amplification.

The OLR is used for amplification, channel power boost, power tilt adjustment, and dispersion compensation in a single-shelf realization, even when Raman pump cards are required.

The OLR is used as a repeater for optical DWDM signals in both 40-channel and 80-channel DWDM transmission systems. The OLR network element structure consists per transmission direction of an optical inline amplifier card with optional external pump card (PL-1), and optional Raman pump card (PRC-1) for maximum span reach. Dispersion compensation for an optical span is applied at the interstage access ports of the related inline amplifier, either as Dispersion Compensation Module (DCM) cards within the shelf, or as separate modules in managed Unidirectional Dispersion Compensation Module (UDCM) trays, depending on the specific fiber type and the required compensation value.

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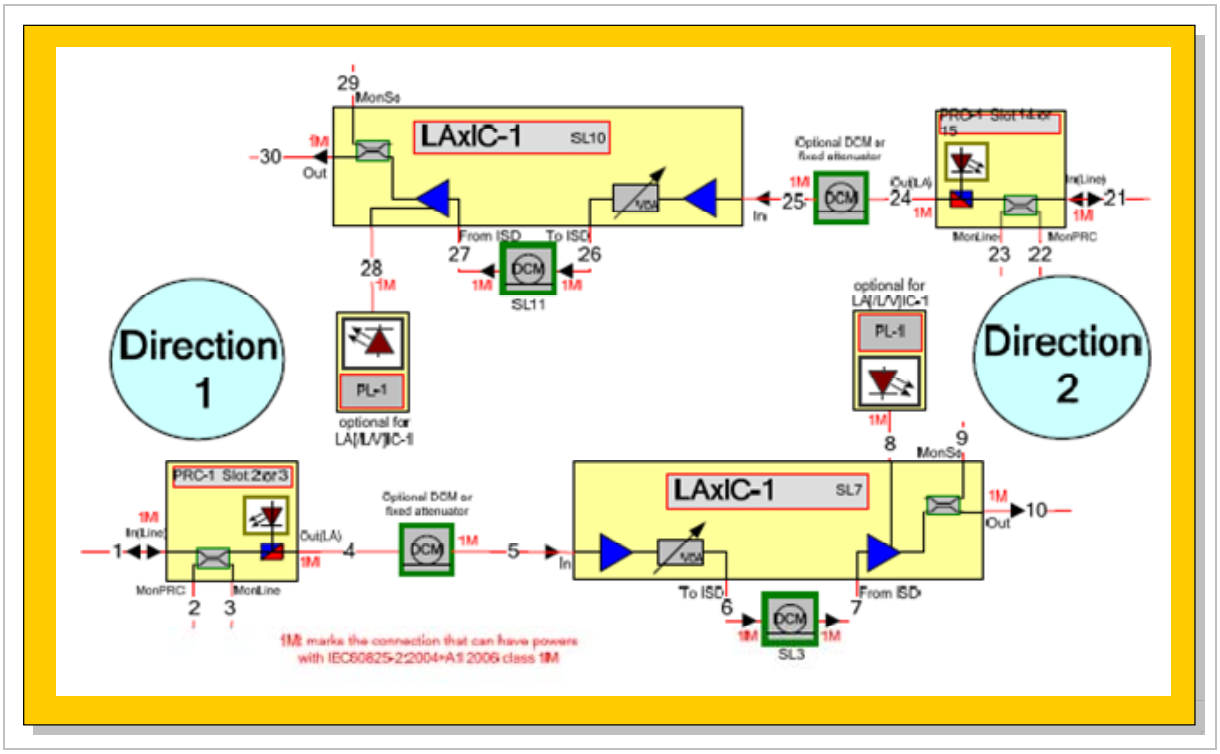

Fig. 122 Block diagram OLR

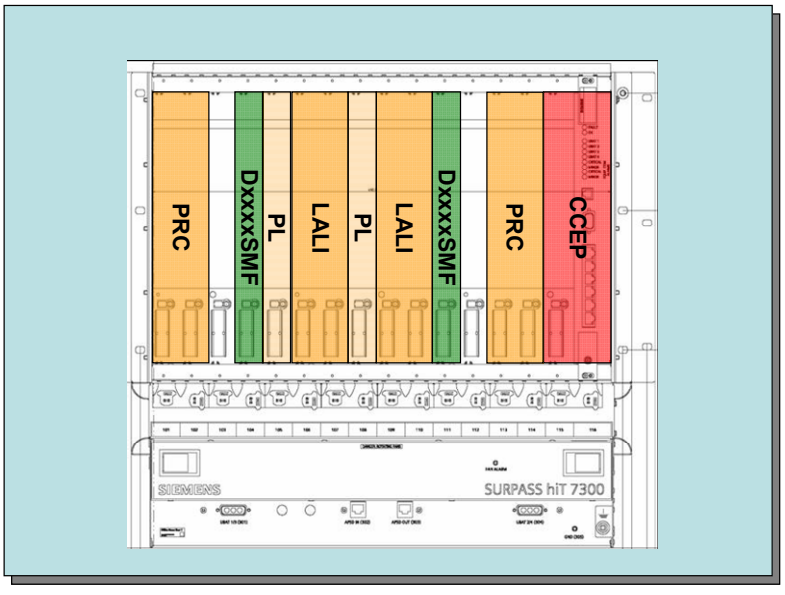

Fig. 123 Example of OLR NE sub-rack equipping

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3.2 Optical Network Node (ONN)

The ONN is a multi-degree optical network node which terminates multiple Optical Multiplex Sections (OMS) by optical multiplexing/demultiplexing of individual optical channels/wavelengths. The number of OMS links terminated by an ONN determines the nodal degree of the ONN.

An ONN realizes a comprehensive family of optical DWDM network elements for implementing fixed Optical Terminal nodes as well as fixed or remotely reconfigurable Optical Add/Drop Multiplexers (OADM or ROADM) and Photonic Cross-Connects (PXC) for multi-degree nodes switching and aggregating traffic from multiple directions.

ONN Sub-type	Filter Structure		ONN Sub-type	Filter Structure	
	Flexible	Full Access		Flexible	Full Access
ONN-T 40	X	X	ONN-R 40/80		X
ONN-T 80		X	ONN-X 40/80		X
ONN-I 40	X	X	ONN-S	X	
ONN-I 80		X	ONN-R2		X
ONN-RT40		X	ONN-RT80		X

In case of flexible filter structure the filter structures for the different EOL channel counts are flexible with respect to the channel upgrade sequence. The following Table shows the example of upgrade sequence chart. The actual task of wavelength planning and card selection is fully automated and performed by TransNet engineering and planning tool.

Upgrade Chart	EOL Channel Count			
	12 ch.	20 ch.	32 ch.	40 ch.
	Filter Type	Filter Type	Filter Type	Filter Type
1st	F04MDU08	F04MDU08	F04MDUC08	F08SB+F04MDN06
2nd	F04MDU06	F08SB+F04MDN06	F08SB+F04MDN06	F04MDN05
3rd	F04MDU05	F04MDN05	F04MDN05	F16SBR+F04MDN08
4th		F04MDN07	F16SBR+F04MDN07	F04MDN07
5th		F04MDN04	F04MDN09	F04MDN09
6th			F04MDN10	F04MDN10
7th			F16SBB+F04MDN04	F16SBB+F04MDN04
8th			F04MDN03	F04MDN03
9th				F04MDN02
10th				F04MDNC01

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Optical Network Node (ONN)

ONN Sub-type	Filter Structure		ONN Sub-type	Filter Structure	
	Flexible	Full Access		Flexible	Full Access
ONN-T 40	X	X	ONN-R 40/80		X
ONN-T 80		X	ONN-X 40/80		X
ONN-I 40	X	X	ONN-S	X	
ONN-I 80		X	ONN-R2		X
ONN-RT40		X	ONN-RT80		X

Fig. 124 Optical Network Node (ONN)

Upgrade sequence chart (flexible filter structure)

Upgrade Chart	EOL Channel Count			
	12 ch.	20 ch.	32 ch.	40 ch.
	Filter Type	Filter Type	Filter Type	Filter Type
1st	F04MDU08	F04MDU08	F04MDUC08	F08SB+F04MDN06
2nd	F04MDU06	F08SB+F04MDN06	F08SB+F04MDN06	F04MDN05
3rd	F04MDU05	F04MDN05	F04MDN05	F16SBR+F04MDN08
4th		F04MDN07	F16SBR+F04MDN07	F04MDN07
5th		F04MDN04	F04MDN09	F04MDN09
6th			F04MDN10	F04MDN10
7th			F16SBB+F04MDN04	F16SBB+F04MDN04
8th			F04MDN03	F04MDN03
9th				F04MDN02
10th				F04MDNC01

Fig. 125 Upgrade sequence chart

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3.2.1 Examples of Flexible filter structure

Flexible filter structure for EOL=12

The following figure displays the filter structure for EOL=12 with the upgrade path from the first channel (group) to the last channel (group). The three 4-channel sub-bands (Cxx) are located within the flat region of the optical amplifier band. The upgrade path allows any upgrade order for three 4-channel sub-bands.

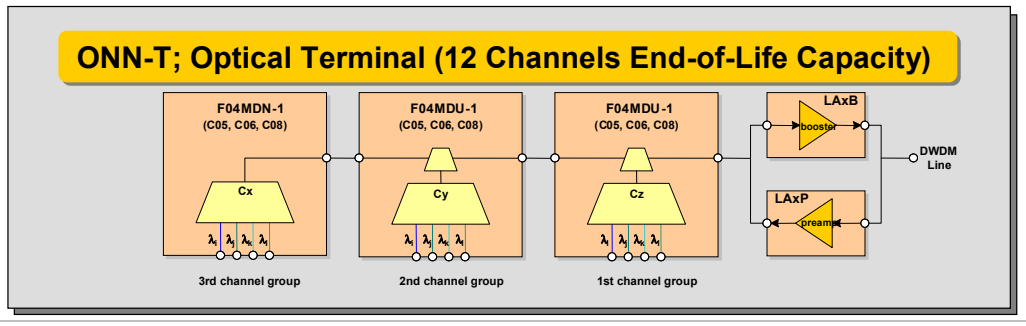

Fig. 126 Example of Flexible filter structure for EOL=12

Flexible filter structure for EOL=20

The following figure displays the basic filter structure for EOL=20 with the upgrade path from the first channel (group) to the last channel (group). The upgrade path allows any upgrade order for these sub-bands.

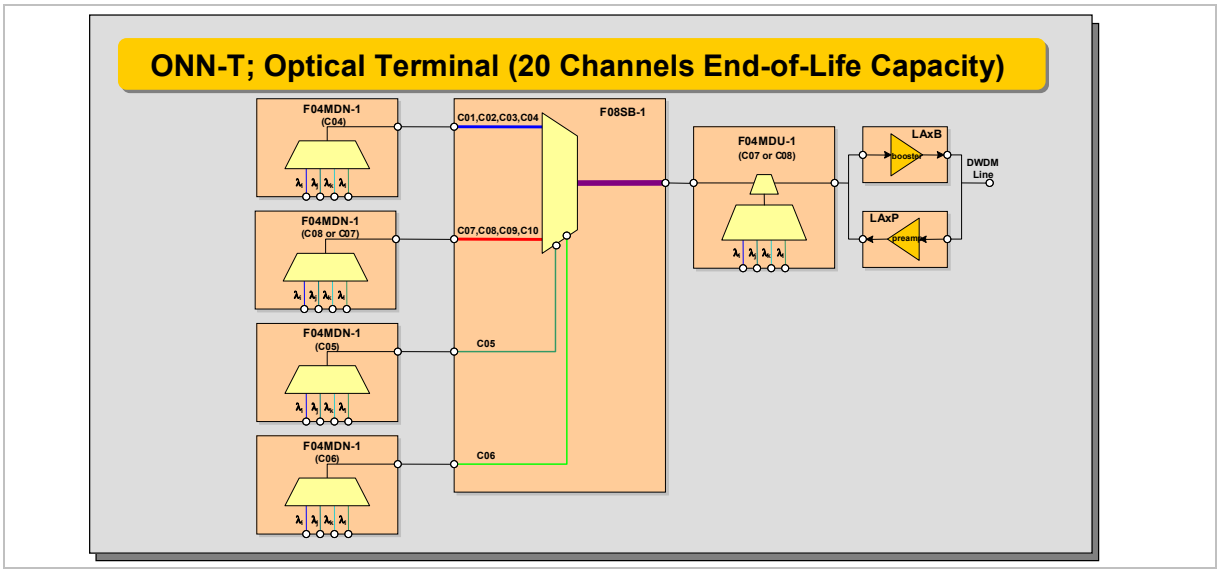

Fig. 127 Example of Flexible filter structure for EOL=20

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Flexible filter structure for EOL=32

The following figure displays the basic filter structure for EOL=32 with the upgrade path from the first channel (group) to the last channel (group). The upgrade path allows any upgrade order for these sub-bands.

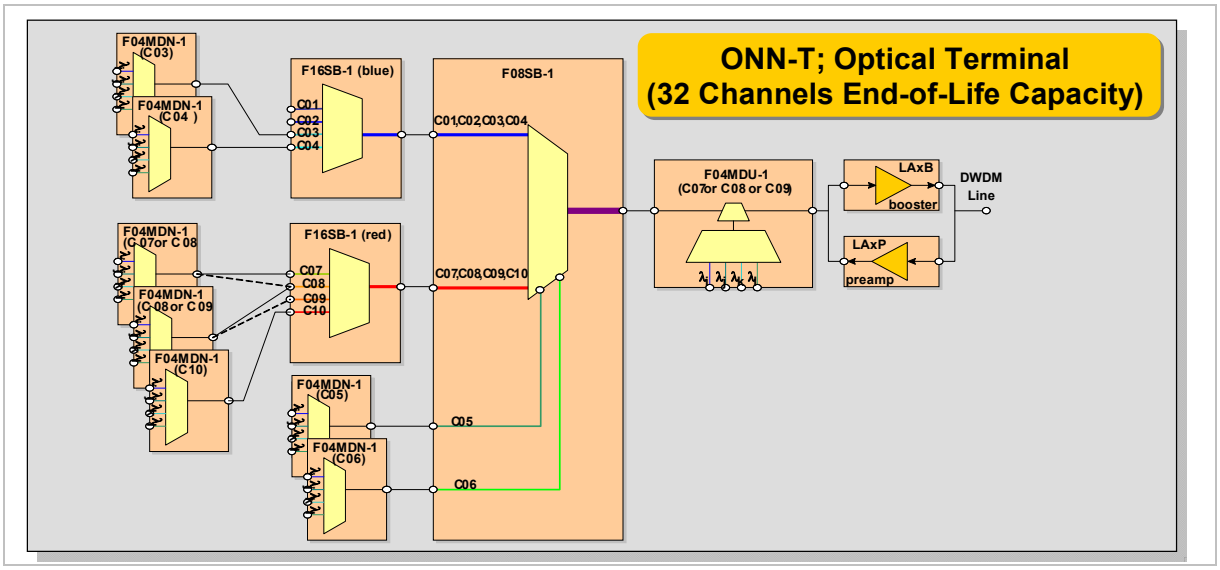

Fig. 128 Example of Flexible filter structure for EOL=32

Flexible filter structure for EOL=40

The following figure displays the basic filter structure for EOL=40 with the upgrade path from the first channel (group) to the last channel (group). The upgrade path allows any upgrade order for these sub-bands. The F08SB-1 card with the red/blue band splitter is always required.

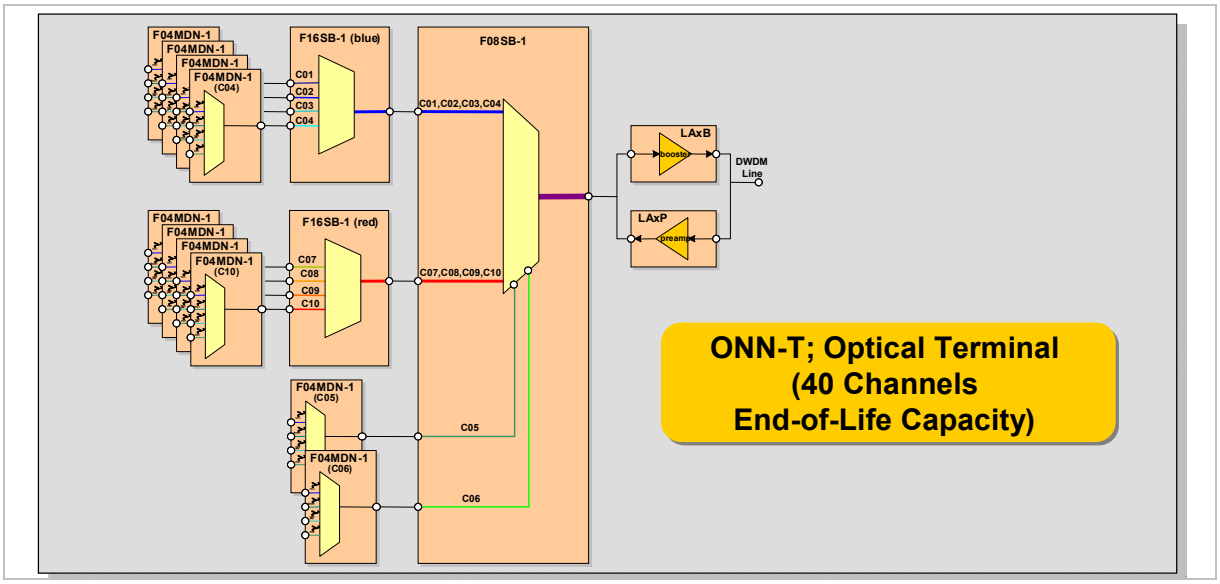

Fig. 129 Example of Flexible filter structure for EOL=40

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3.2.2 Optical Network Node - Terminal, (ONN-T)

The ONN-T is a DWDM NE which is used in Terminal 1/2 OADM architecture. It multiplexes and demultiplexes all channels. The basic ONN-T structure consists of transponder cards, filter cards, and optical line amplifier cards (with optional external pump card(s) and with optional Raman pump card for maximum span reach). Dispersion compensation for an optical span is applied at the interstage access ports of the related amplifier, either as DCM cards within the shelf, or as separate modules in managed UDCM trays, depending on the specific fiber type and the required compensation value.

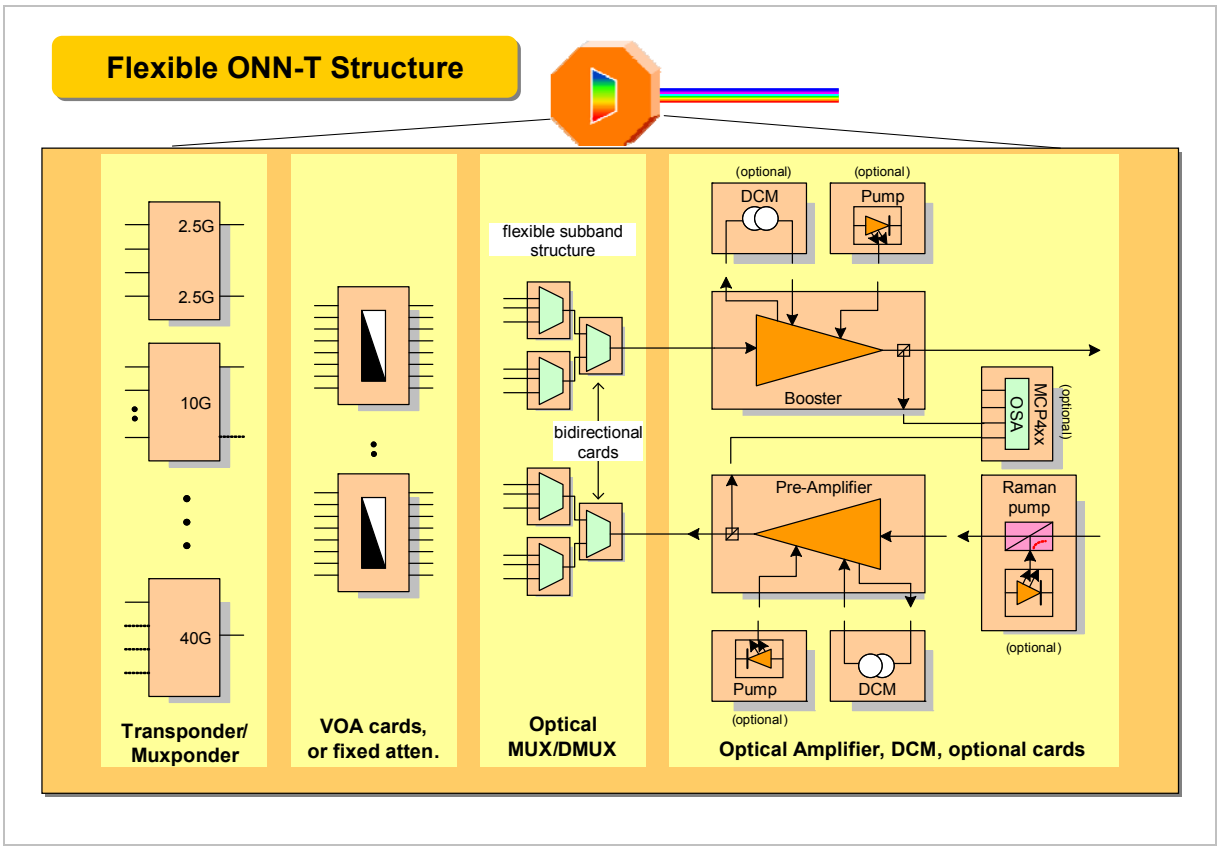

Fig. 130 Flexible Optical Terminal ONN-T

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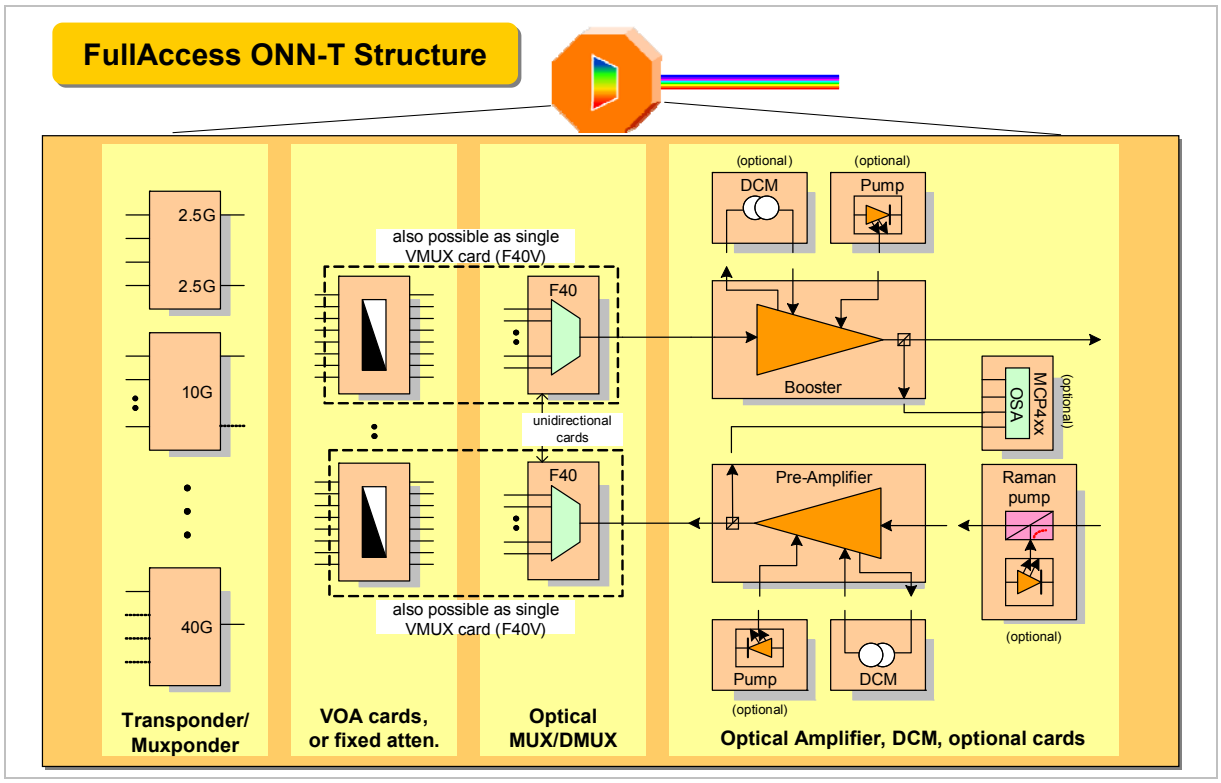

Fig. 131 FullAccess Optical Terminal ONN-T

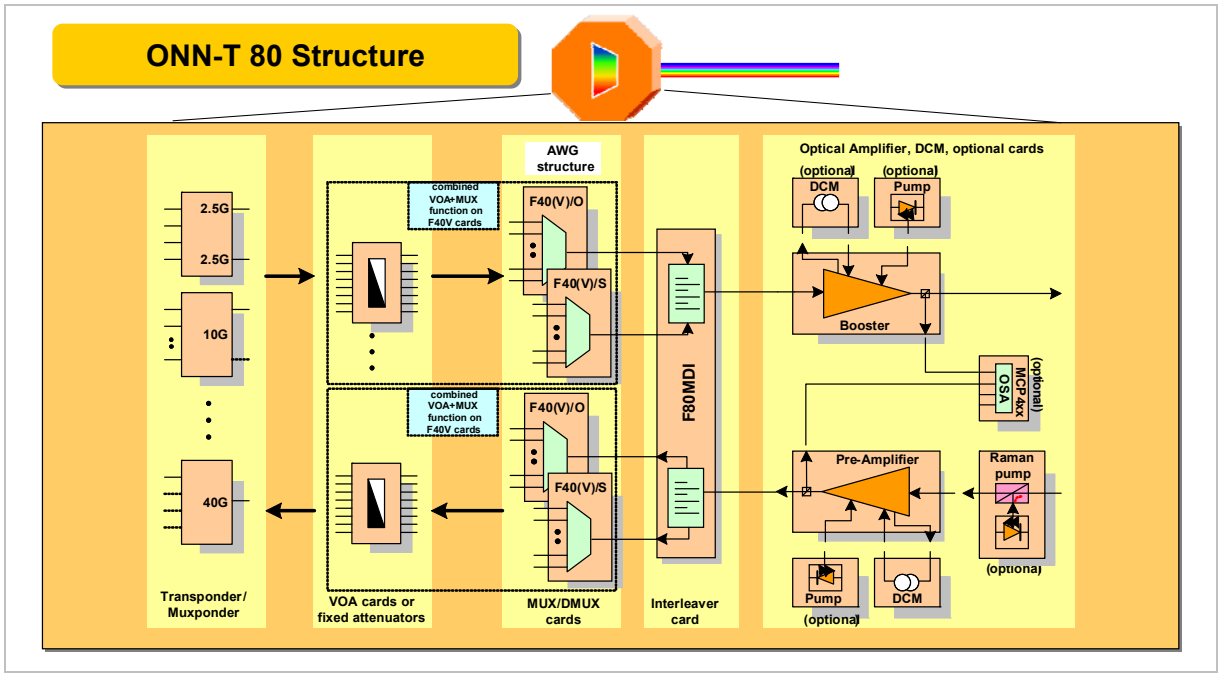

Fig. 132 ONN-T 80 structure

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3.2.3 Optical Network Node - Interconnect (ONN-I)

The ONN-I is a DWDM NE which is used in Flexible or FullAccess OADM architecture. It is used for amplification, dispersion compensation, termination of links, and optical channel termination via transponders. The basic ONN-I structure consists of transponder cards (if channels termination is required), filter cards, and optical line amplifier cards (with optional external pump card(s) and with optional Raman pump card for maximum span reach). Dispersion compensation for an optical span is applied at the interstage access ports of the related amplifier, either as Dispersion Compensation Module (DCM) cards within the shelf, or as separate modules in managed UDCM trays depending on the specific fiber type and the required compensation value.

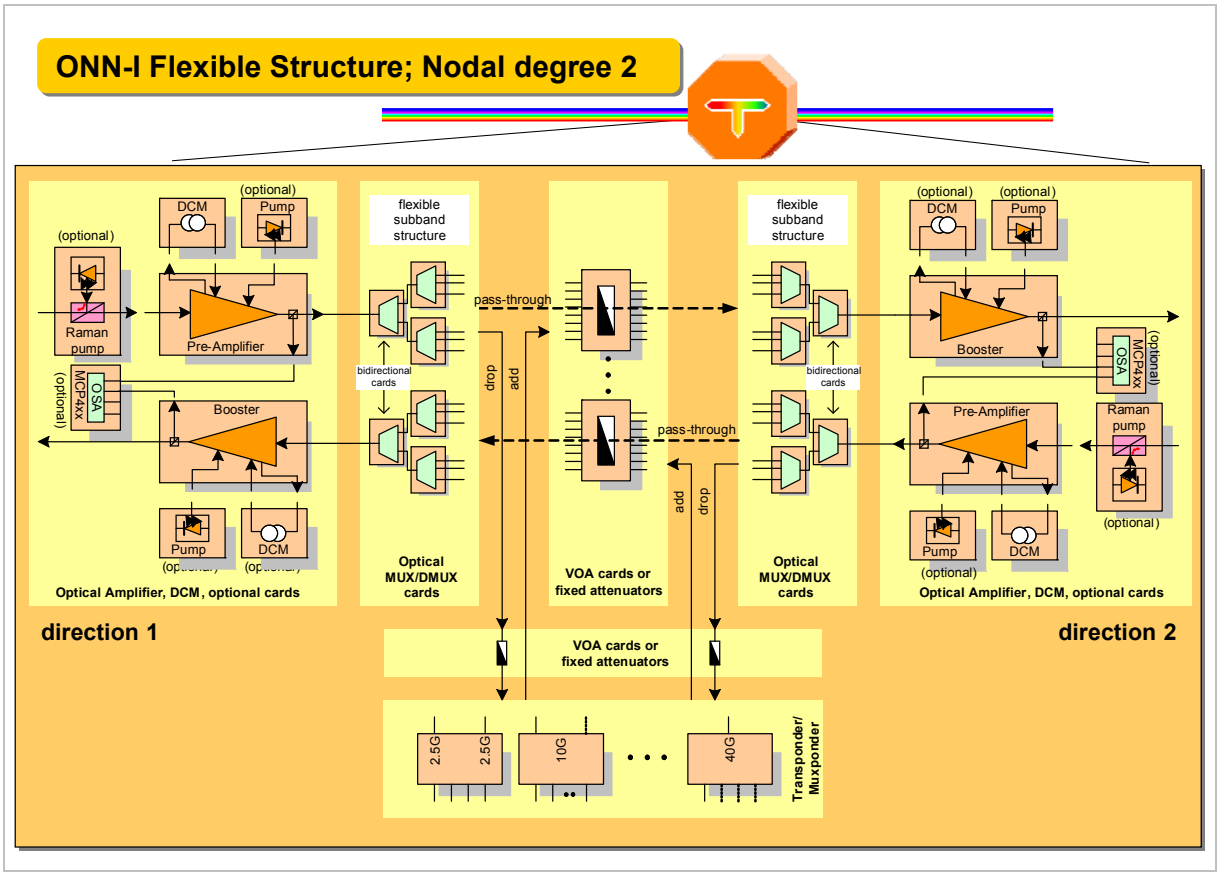

Fig. 133 Optical Network Node - Interconnect (ONN-I)

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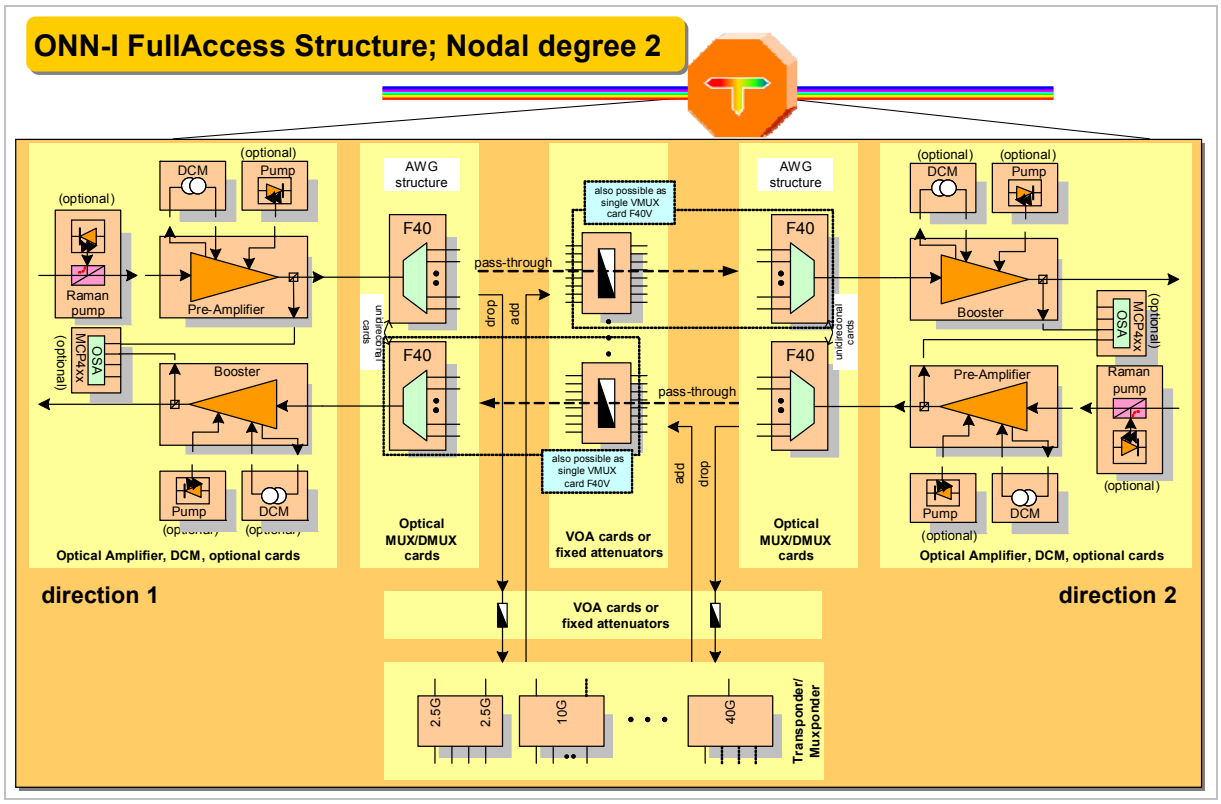

Fig. 134 Optical Network Node - Interconnect (ONN-I)

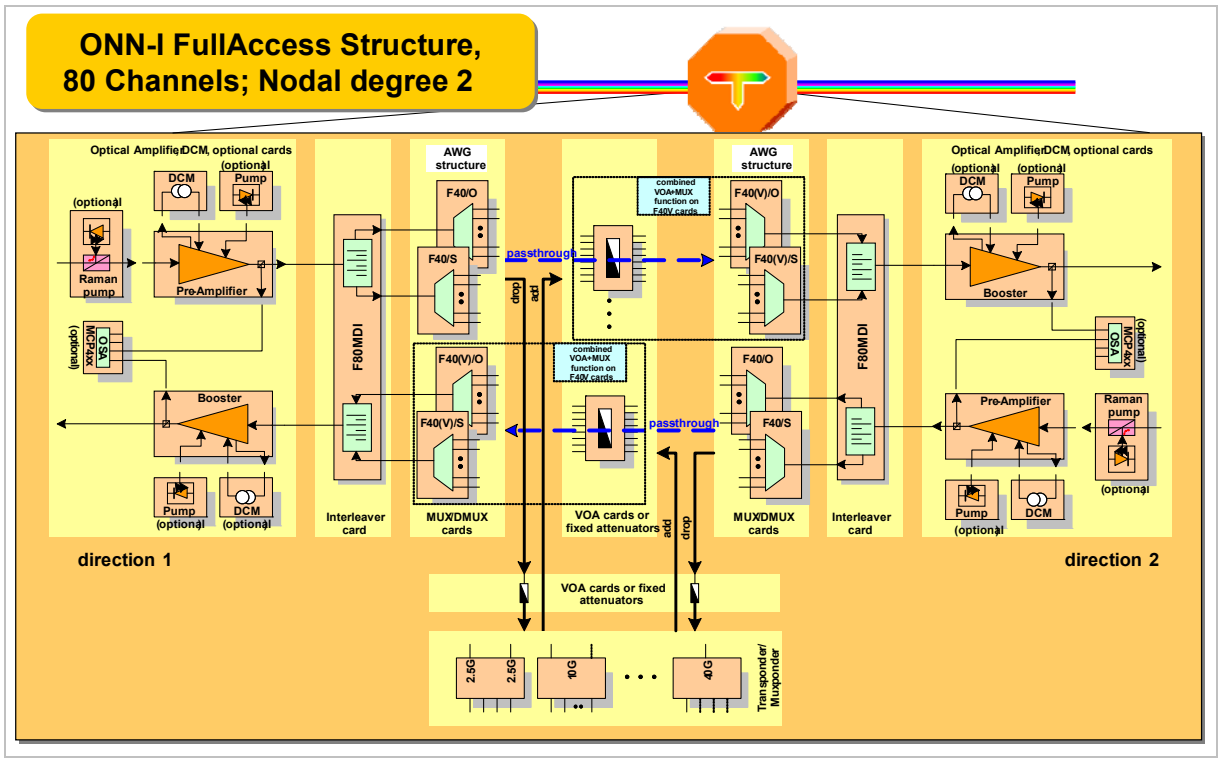

Fig. 135 Optical Network Node - Interconnect (ONN-I)

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3.2.4 Optical Network Node - Reconfigurable (ONN-R)

The ONN-R is a DWDM NE which is used in FullAccess OADM, or ROADM architectures by combining the functions of optical channel multiplexing/demultiplexing and optical channel (wavelengths) switching to a very compact solution of a (remotely) reconfigurable optical add/drop multiplexer with 100% access to all 40 optical channels on a DWDM line interface. The basic ONN-R structure consists of transponder cards (if channels termination is required), filter cards (F40MR-1 cards and F40-1 cards if add/drop of a single channel is required), optical line amplifier cards (with optional external pump card(s) and with optional Raman pump card for maximum span reach). Dispersion compensation for an optical span is applied at the interstage access ports of the related amplifier, either as DCM cards within the shelf, or as separate modules in managed UDCM trays depending on the specific fiber type and the required compensation value.

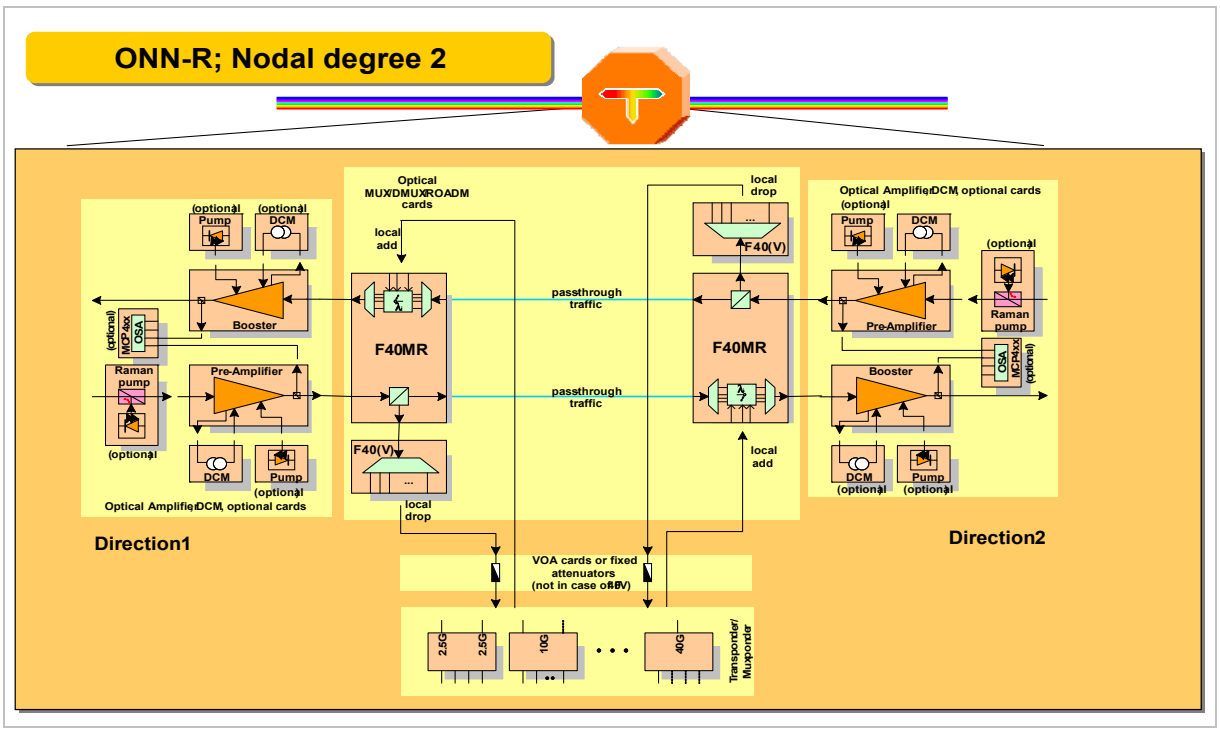

Fig. 136

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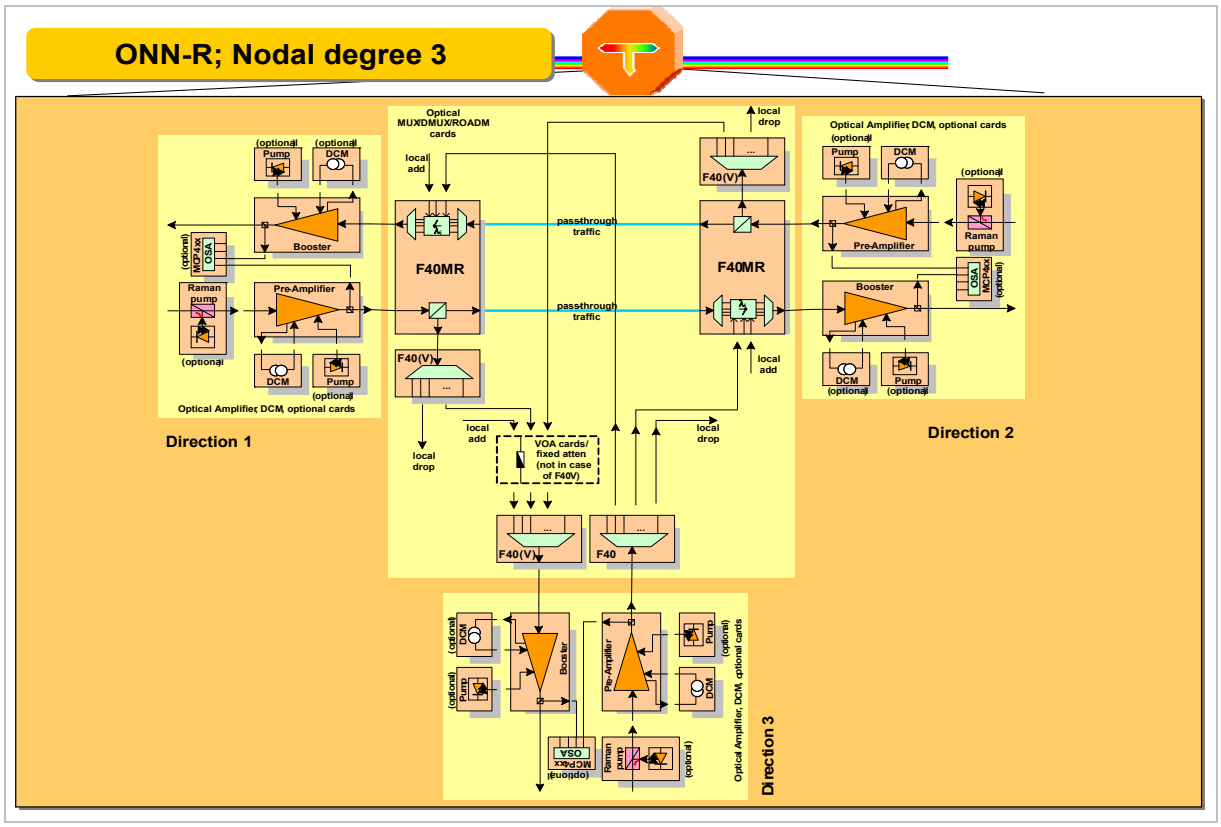

Fig. 137

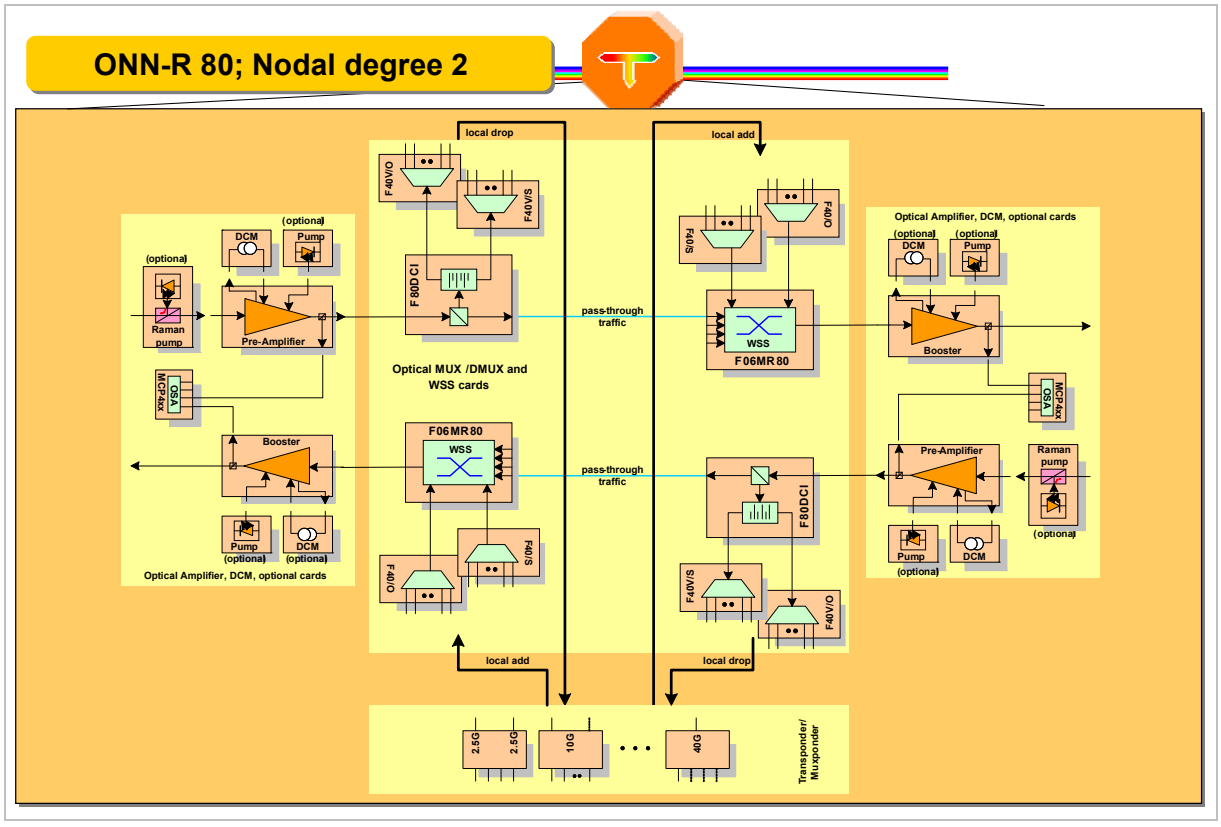

Fig. 138

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3.2.5 Optical Network Node – Small, ONN-S

The ONN-S is a 40-channel DWDM NE in Small OADM architecture. It is used for amplification and link start-up of add/drop-channels within an optical path. The ONN-S is cost-optimized for network applications with only a small number of add/drop-channels at intermediate sites, where up to 8 channels out of two 4-channel sub-bands can be added/dropped from each of the 2 line directions.

The ONN-S only uses a partial optical multiplexing/demultiplexing scheme for the channels to be locally accessed, while all other optical channels are automatically passed-through as express traffic.

Each line interface of the ONN-S structure consists of an optical booster and pre-amplifier, dispersion compensation cards, and optional external pump card(s) and Raman pump card for the booster. The ONN-S has a maximum add/drop capacity of 8 channels. Channels that are dropped at an ONN-S are terminated at the client equipment.

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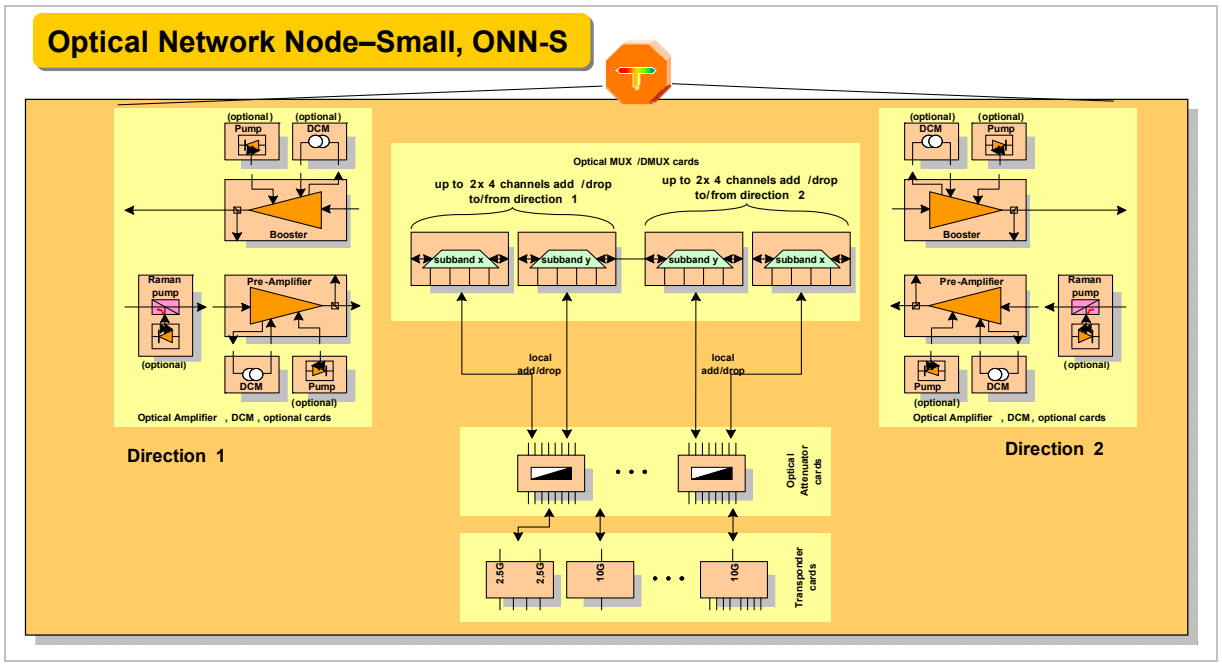

Fig. 139 Optical Network Node – Small, ONN-S

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3.2.6 Optical Network Node - ONN-R2

ONN-R2 is a ROADM with F02MR-1 nodal degree 2.

The ONN-R2 is a 40-channel DWDM NE which is used in a ROADM architecture to provide optical channel multiplexing/demultiplexing and optical channel (wavelengths) switching in a very compact solution of a remotely reconfigurable optical add/drop multiplexer with 100% access to all 40 optical channels on a DWDM line interface.

When compared with the ONN-R, the ONN-R2 is **restricted to nodal degree 2** applications and his basic structure consists of transponder cards (if channels termination is required), filter cards (two **F02MR-1** and four **F40(V)-**1 or F04MDU-1 cards for local add/drop), optical line amplifier cards (with optional external pump card(s) (PL-1) and with optional Raman pump card (PRC-1) for maximum span reach). Dispersion compensation for an optical span is applied at the interstage access ports of the related amplifier, either as DCM cards within the shelf, or as separate modules in managed UDCM trays depending on the specific fiber type and the required compensation value The **ONN-R2 is a more cost optimized alternative to the ONN-R** in applications that do not require a higher nodal degree or low add-loss.

Any OTN using ONN-R2 NEs provides a dynamic wavelength provisioning across the DWDM network, therefore, allowing a modification of the customer traffic demands without manual equipment installation at intermediate locations by local field service personnel (OPEX reduction).

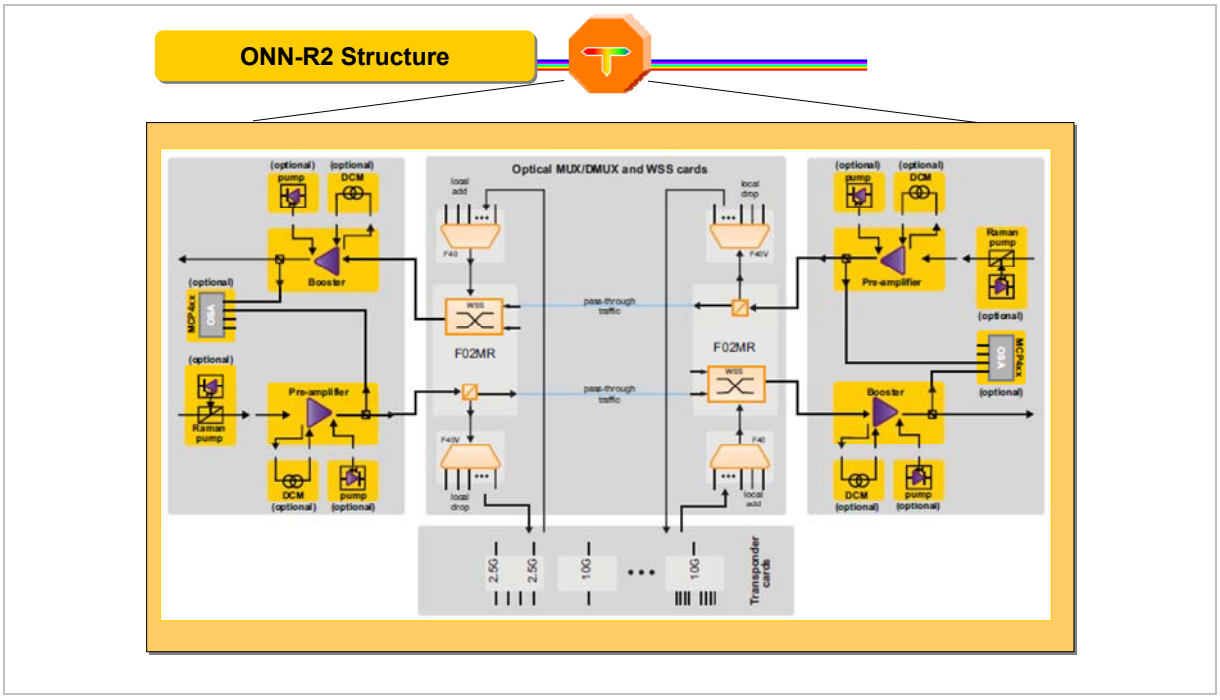

Fig. 140 ONN-R2 Structure

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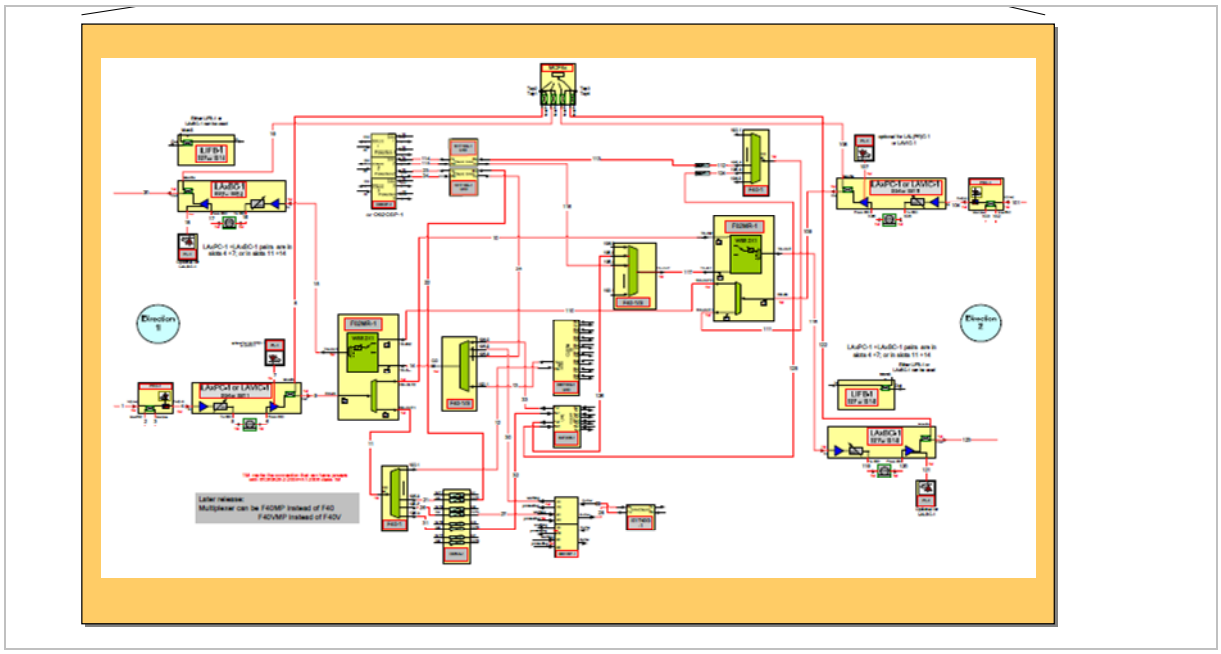

Fig. 141Block diagram ONN-R2

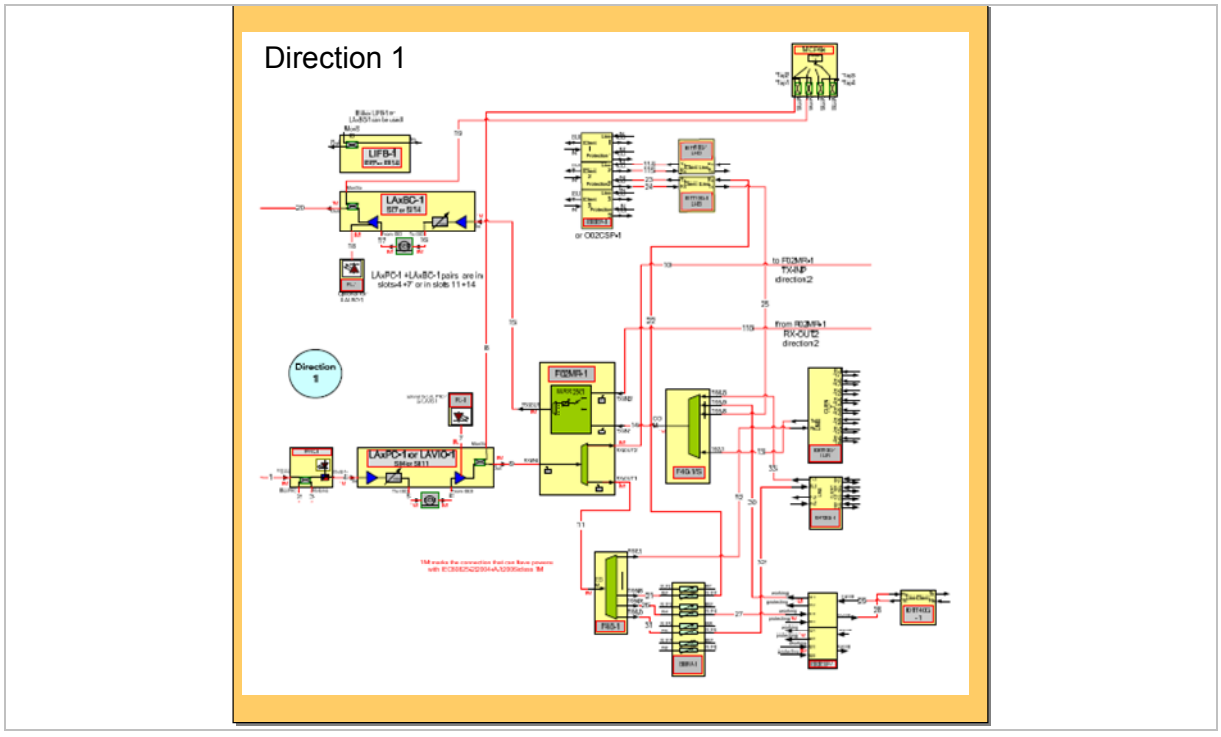

Fig. 142Block diagram (Direction 1)

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3.2.7 Optical Network Node - ONN-RT

Optical Network Node - ONN-RT is an Colorless ROADM w/F09MDRT-1/x nodal degree 2.

The ONN-RT is a 40-channel DWDM NE which is used in a Metro tunable ROADM architecture by combining the functions of optical channel multiplexing/demultiplexing and optical channel (wavelengths) switching into a very compact solution of a (remotely) reconfigurable optical add/drop multiplexer with 100% access to all 40 optical channels on a DWDM line interface.

The basic 40-channel ONN-RT structure consists of transponder cards (if channels termination is required), **F09MDRT-1/S filter cards**, and optical line amplifier cards (with optional external pump card(s) (PL-1) and with optional Raman pump card (PRC-1) for maximum span reach). Dispersion compensation for an optical span is applied at the interstage access ports of the related amplifier, either as DCM cards within the shelf, or as separate modules in managed UDCM trays depending on the specific fiber type and the required compensation value.

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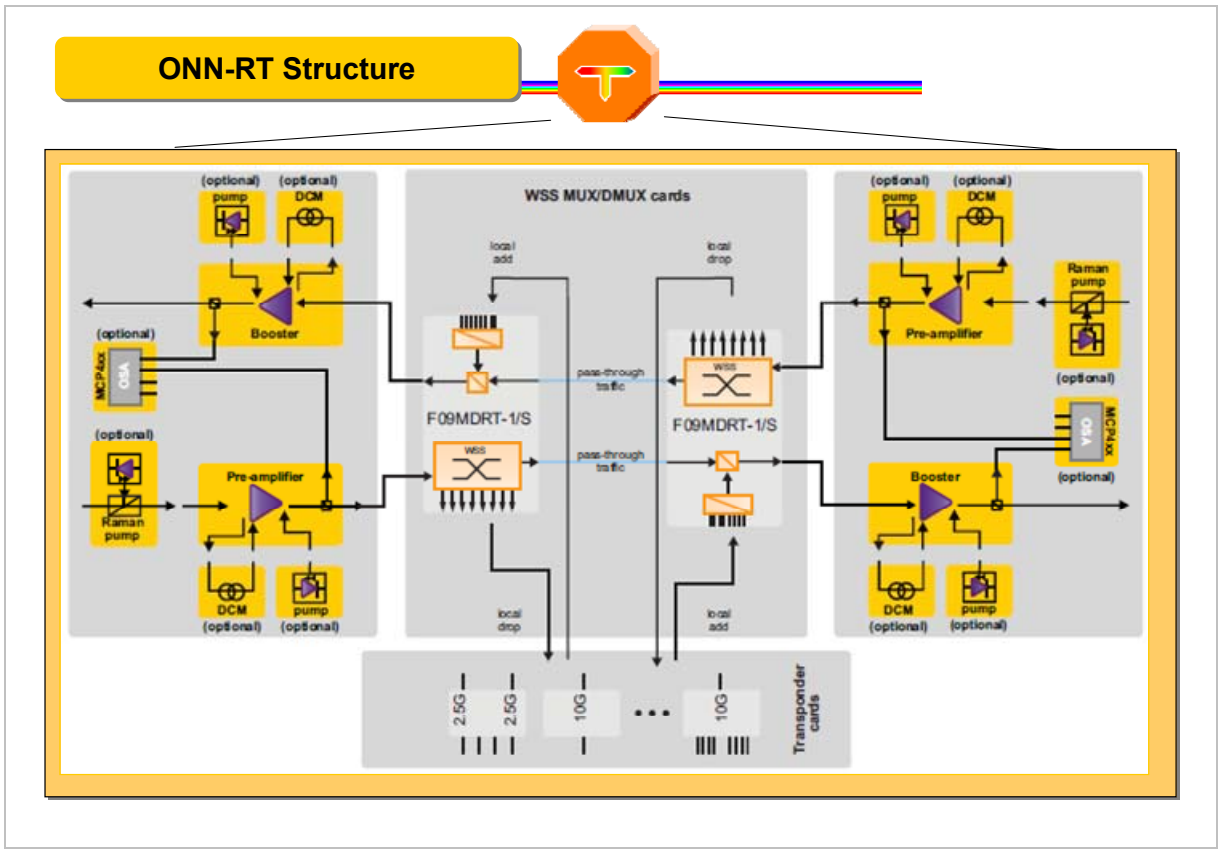

Fig. 143

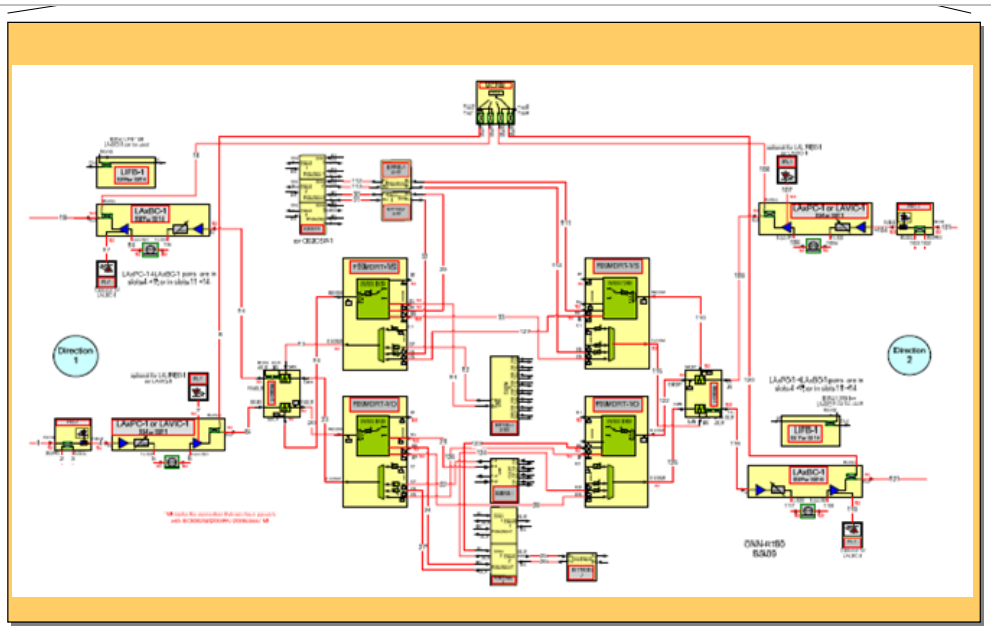

Fig. 144

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3.2.8 Optical Network Node - Reconfigurable/Tunable (80 channels) – ONN-RT(80)

The ONN-RT80 is a 80-channel DWDM NE which is used in a Metro tunable ROADM architecture by combining the functions of optical channel multiplexing/demultiplexing and optical channel (wavelengths) switching into a very compact solution of a (remotely) reconfigurable optical add/drop multiplexer with 100% access to all 40 optical channels on a DWDM line interface.

The basic **80-channel ONN-RT** structure consists of transponder cards (if channels termination is required), filter cards (two **F09MDRT-1/S**, two **F09MDRT-1/O**, and two **F80MDI**), and optical line amplifier cards (with optional external pump card(s) (PL-1) and with optional Raman pump card (PRC-1) for maximum span reach). Dispersion compensation for an optical span is applied at the interstage access ports of the related amplifier, either as DCM cards within the shelf, or as separate modules in managed UDCM trays depending on the specific fiber type and the required compensation value.

As the ONN-RT the ONN-RT80 **supports 16 colorless add/drop channels** per direction.

Each add/drop wavelength is tunable and remotely configurable.

Any OTN using ONN-RT80 NEs provides a dynamic wavelength provisioning across the DWDM network, therefore, allowing a modification of the customer traffic demands without manual equipment installation at intermediate locations by local field service personnel (OPEX reduction).

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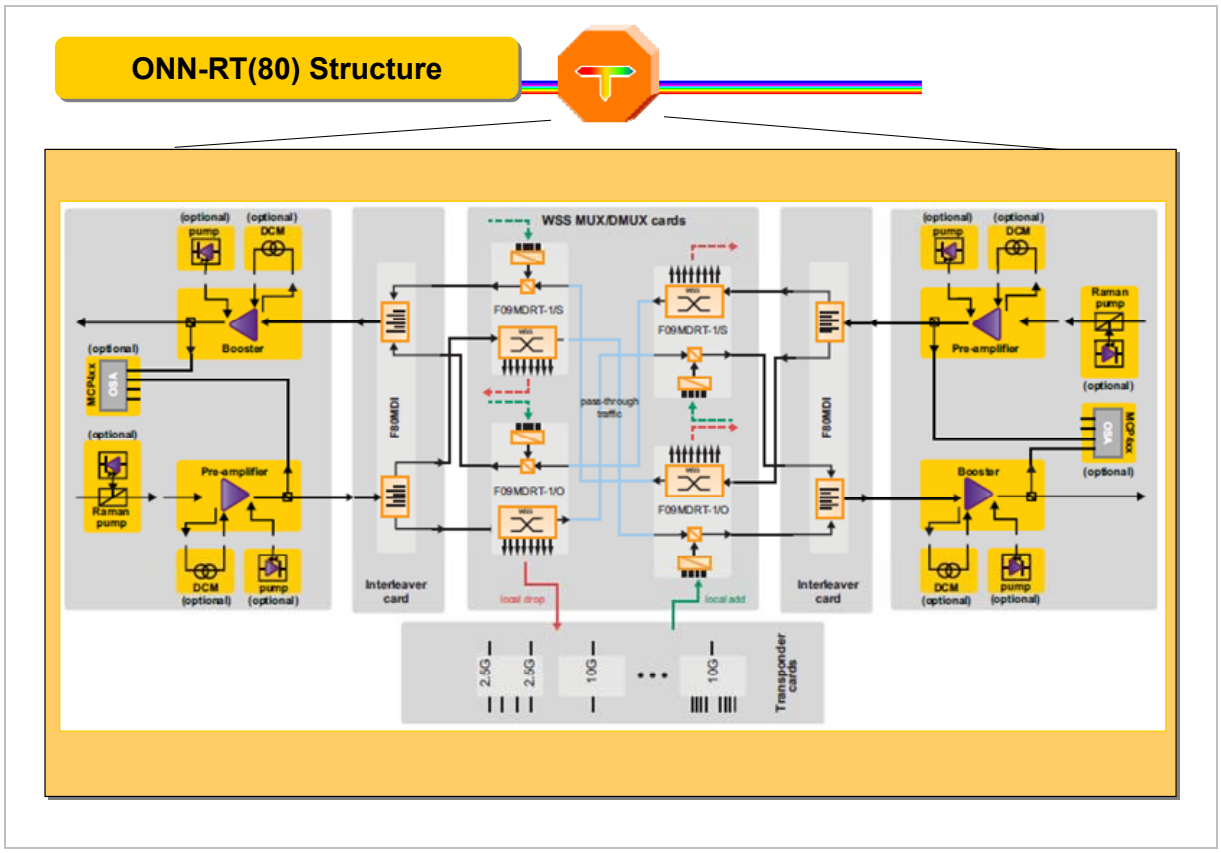

Fig. 145 ONN-RT(80) Structure

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3.2.9 Optical Network Node - Cross-Connect (ONN-X)

The ONN-X is an advanced 40-channel DWDM NE which is used in PXC architecture. The basic 40-channel ONN-R structure consists of transponder cards (if channels termination is required) and an optical channel switching matrix filter card (F80MR-1). The F80MR-1 card, in the transmitting direction of the DWDM line, realizes a reconfigurable optical switch matrix with low insertion loss for each individual wavelength to select per wavelength between 40 input optical channels received from any other DWDM line port and 40 multiplexed wavelengths of local incoming channels. In the receiving direction of the DWDM line, a passive optical splitter forwards the received line signal to both pass through traffic and drop traffic output ports. Drop traffic is then demultiplexed into individual channels by a F40(V)-1 filter demultiplexer card. For the counter-directional line traffic, another combination of F08MR-1 and F40(V)-1 cards perform the analog channel switching and demultiplexing functions. Pass-through traffic between 2 line directions is forwarded by direct DWDM interconnections between the corresponding F08MR-1 cards.

In each line section the ONN-X structure also includes optical amplifier cards (with optional external pump card(s) (PL-1) and with optional Raman pump card (PRC-1) for maximum span reach). Dispersion compensation for an optical span is applied at the interstage access ports of the related amplifier, either as DCM cards within the shelf, or as separate modules in managed UDCM trays depending on the specific fiber type and the required compensation value.

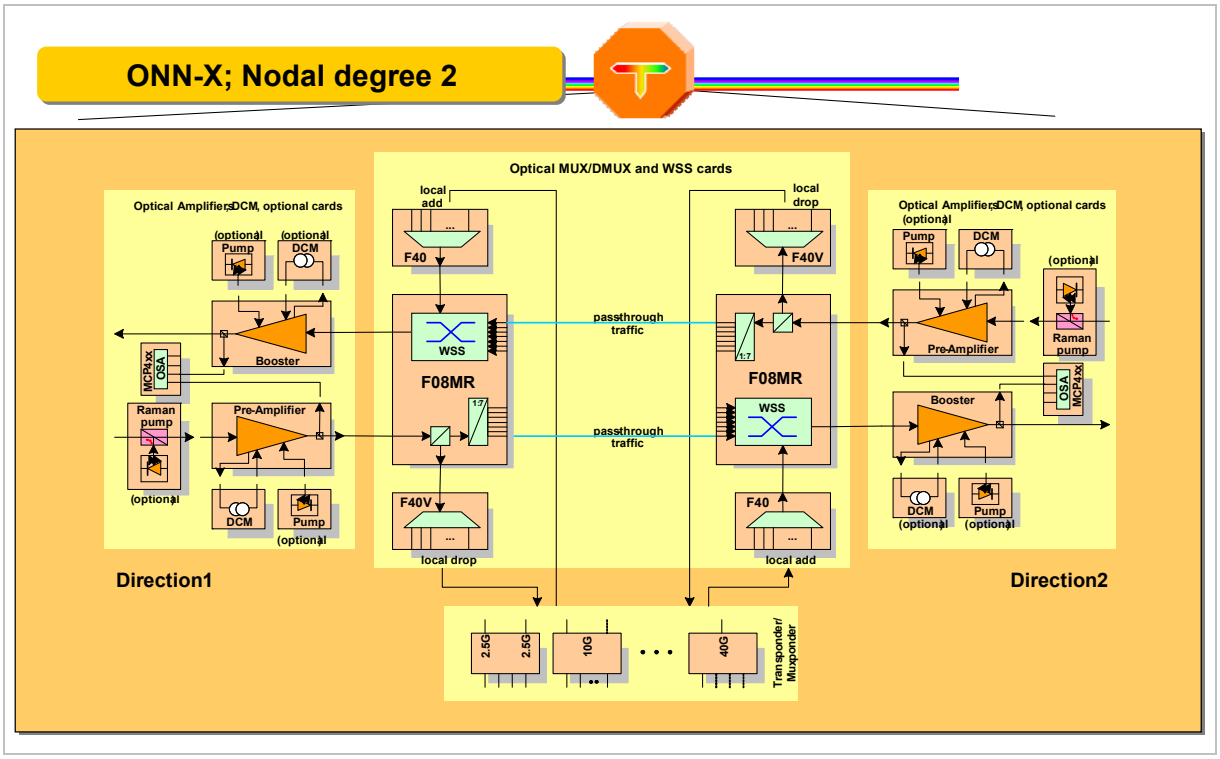

Fig. 146

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3.2.9.1 Optical Network Node - Cross-Connect - PXC up to nodal degree 8

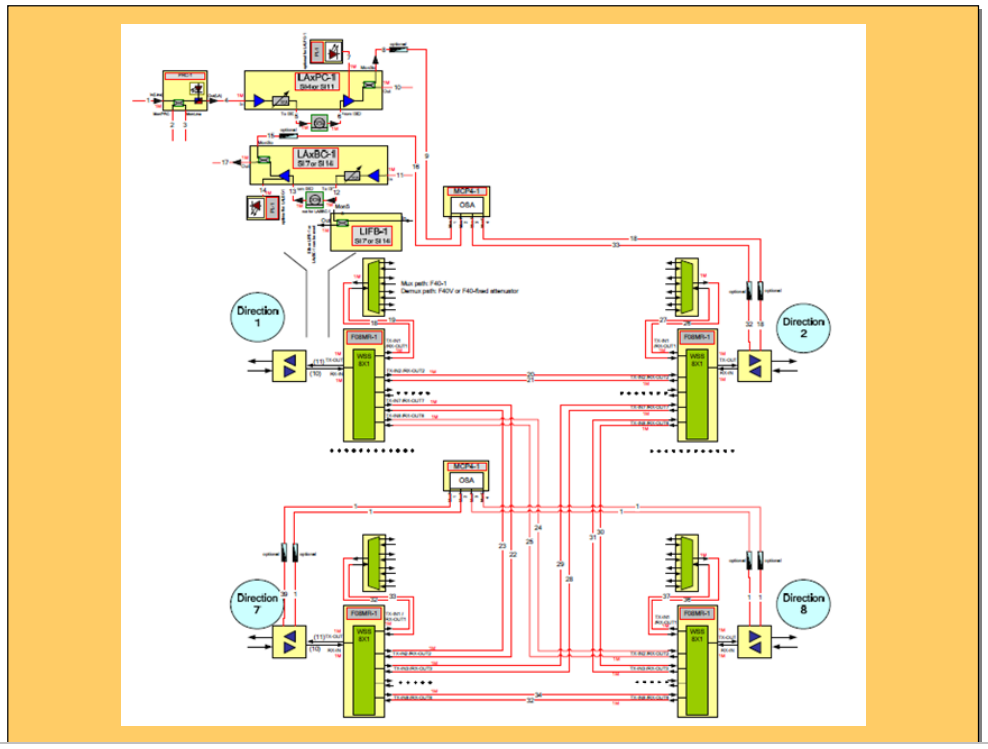

Fig. 147 ONN-X; Nodal up to degree 8

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3.2.10 Optical Network Node - Cross-Connect 80 channels – ONN-X80

The ONN-X80 is an advanced 80-channel DWDM NE which is used in a PXC architecture.

The basic 80-channel ONN-X80 structure consists of transponder cards (if channels termination is required), **F06MR80-1 and F06DR80-1 MEMS-WSS filter cards** for optical channel switching in multiplexing (transmitting) and demultiplexing (receiving) directions at each line interface, respectively, therefore forming a double-WSS structure.

The traffic to be locally dropped is divided by the WSS of the corresponding **F06DR80- 1** filter card into 2 groups of 40 channels with 100GHz spacing using standard frequency grid and offset frequency grid, respectively. Each 40-channel drop group is amplified by a low-cost LASB-1 amplifier before being demultiplexed into individual drop-channels by the F40-1 demultiplexer filter card.

The traffic to be locally added to a DWDM line is first multiplexed into 2 groups of 40 channels with 100GHz spacing using standard frequency grid and offset frequency grid by the respective F40-1 multiplexer filter card. Each 40-channel add group is then aggregated by the WSS of the corresponding F06MR80-1 card, which also performs optical channel switching between local add channels and pass-through channels from any other DWDM line interface(s) of other direction(s).

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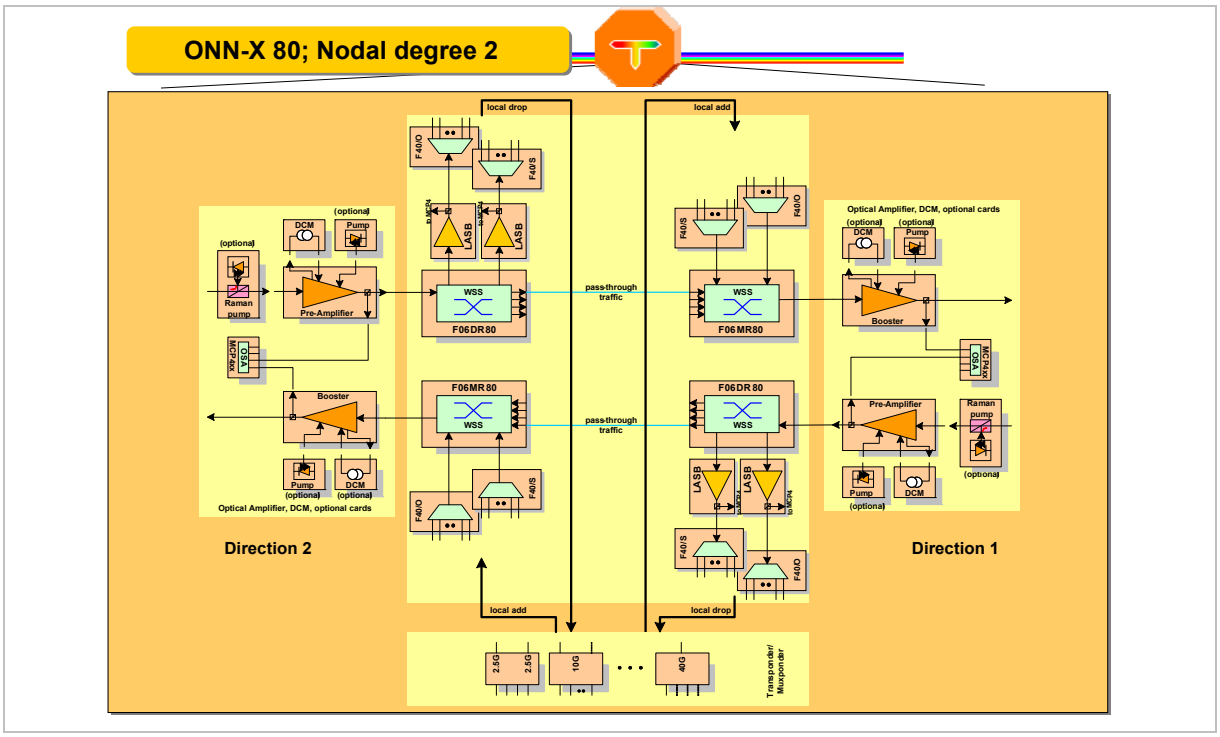

Fig. 148

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3.2.11 Optical Network Node - Cross-Connect 96 channels – ONN-X96

The ONN-X96 is an advanced 96-channel DWDM NE which is used in a PXC architecture with DCM-free transmission. The basic ONN-X96 structure consists of transponder cards (if channels termination is required) and F09MDR96-1 bidirectional tunable WSS filter card for optical channel switching in multiplexing (transmitting) and demultiplexing (receiving) directions at each line interface, respectively.

The ONN-X96 supports two add/drop structures, directional fixed frequency add/drop supported by F48MDP-1 cards and colorless and directionless add/drop supported by F09MDR96-1 cards and O09CC-1 for aggregation. A mixture of both add/drop structures is supported, see an example in figure.

The ONN-X96 supports up to 8 nodal degrees plus two colorless and directionless structures. Additional colorless and directionless structures are possible, to a maximum of 5.

For each additional structures the maximum nodal degree is reduced by one. For example, with 4 colorless and directionless structures is possible to have up to 6 nodal degrees.

For each line section, the ONN-X96 structure includes optical amplifier cards optimized for DCM-free networks (LABPC-1, LABBC-1), optional Raman pump card (PRC-2) for maximum span reach, optional channel power monitor card (MCP4-2) for monitoring of the optical channel power levels and optional transient suppression for C-band card (OTSC-1) for transient protection. When OTSC card is used the system is limited to 80 traffic channels.

Directional fixed frequency

The directional fixed frequency structure is the most simple and cost effective technology to add/drop channels. Each port of the add/drop structure supports only one specific wavelength, each add/drop structure supports only one specific fiber degree and within the fiber degree, only one direction. This is ideally suited for static and directional traffic patterns.

The traffic to be locally dropped is divided by the F09MDR96-1 filter card into 2 groups of 48 channels with 50GHz spacing using standard frequency grid and offset frequency grid.

The traffic to be locally added to a DWDM line is first multiplexed into 2 groups of 48 channels with 50 GHz spacing using standard frequency grid and offset frequency grid by the respective F48MDP-1 multiplexer filter card. Each 48-channel add group is then aggregated in the F09MDR96-1 card by one of the WSS, which also performs optical channel switching between local add channels and pass-through channels from any other DWDM line interface(s) of other direction(s).

Pass-through traffic between any line direction is forwarded by direct DWDM interconnections between F09MDR96-1 filter cards.

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Colorless and directionless

The colorless and directionless is a flexible technology to add/drop channels. Each port of the add/drop structure can access any wavelength from any direction of any degree within a node. It is therefore ideally suited for highly flexible traffic patterns.

The add/drop structure consists of WSS based switches (F09MDR96-1 used with the double WSS switching matrix resulting in reduced complexity) and splitters/ combiners (O09CC-1).

Logically it is divided into a directionless layer and a colorless layer. The directionless layer consists of one F09MDR96-1 switch, two LABxC-1 amplifiers and one splitter/combiner card (O09CC-1). Each port of the F09MDR96-1 can be connected to any WSS or splitter used in the switching matrix, allowing it to access all degrees.

The colorless layer consists of up to 9 F09MDR96-1 cards, each one connected to one port of the directionless layer. It is able to drop 9 different channels each, leading to a maximum of 81 tunable ports which can be freely chosen from the overall 96 available channels. F09MDR96-1 cards can be added in increments when demand increases without traffic impact. If more than 81 channels need to be dropped (colorless or two or more identical wavelengths need to be dropped), additional add/drop structures can be

added.

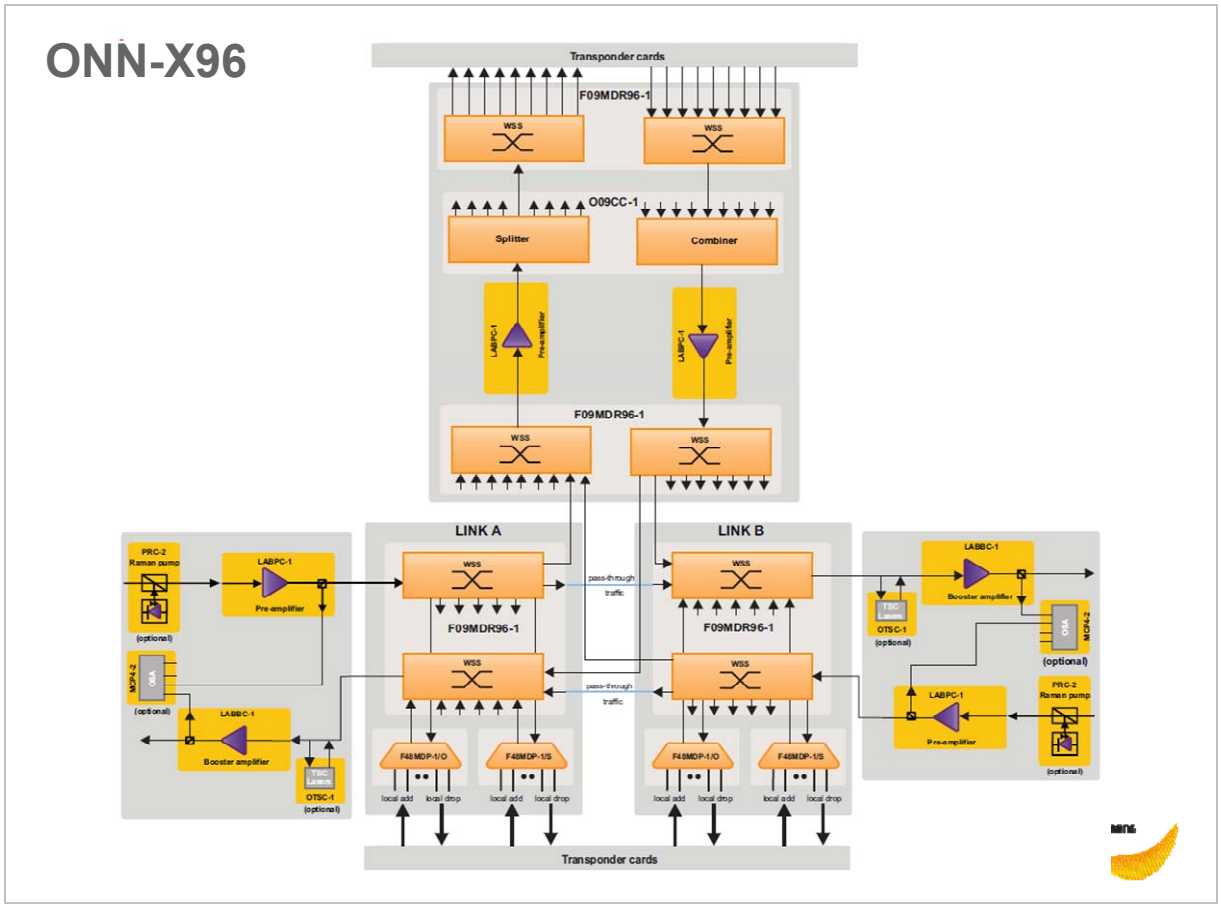

Fig. 149

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3.3 SON – Standalone Optical Node

The SON network element is a derivative of the ONN for use as a stand-alone NE for the following applications:

3.3.1 Transponder NE

SON NE can be used as Pure Transponder NE as a feeder system for:

- hiT7500 DWDM system;
- any 3rd party DWDM system.

It provides the capability to use any hiT7300 transponder card, as a feeder to the optical channels of a DWDM system, thereby enabling the benefits of the hiT7300 transponders cards for alternative applications. The SON also supports optical channel protection. Using the tunable transponder card types of hiT7300 also compliance to a 50 GHz DWDM grid is achieved.

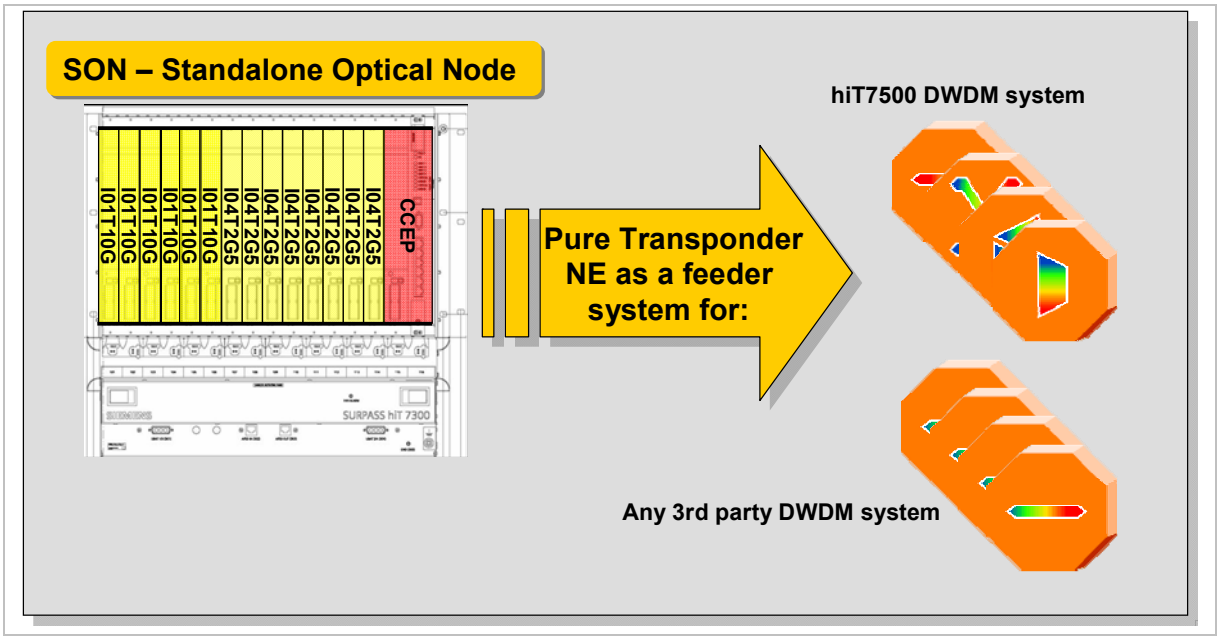

Fig. 150 hiT7300 SON as a Pure Transponder NE

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3.3.2 Pure Passive Terminal or OADM (amplifier-less)

hiT7300 SON NE can be used as a simple low-cost DWDM system with up to 40 optical channels for short reach applications in metropolitan areas. It provides the capability to use the hiT7300 transponder and optical multiplexer/de-multiplexer cards without any optical amplifier cards. Also optical network configurations consisting of a linear chain of passive optical terminals with intermediate passive OADM can be build by SON NE's.

The multiplexing structure for a passive Terminal/OADM can be realized either by flexible filter structure depending on the required number of channels, or by the F40-1 filter cards providing access to all 40 channels already for first installation. Any flexible filter structure is supported which consists of a cascade of F04MDU filters cards optionally terminated by an F04MDN, which allows incremental upgrading in steps of 4-channel groups; alternatively the F08SB filter card as red/blue splitter can be used providing the advantage of lower insertion loss with higher number of channels.

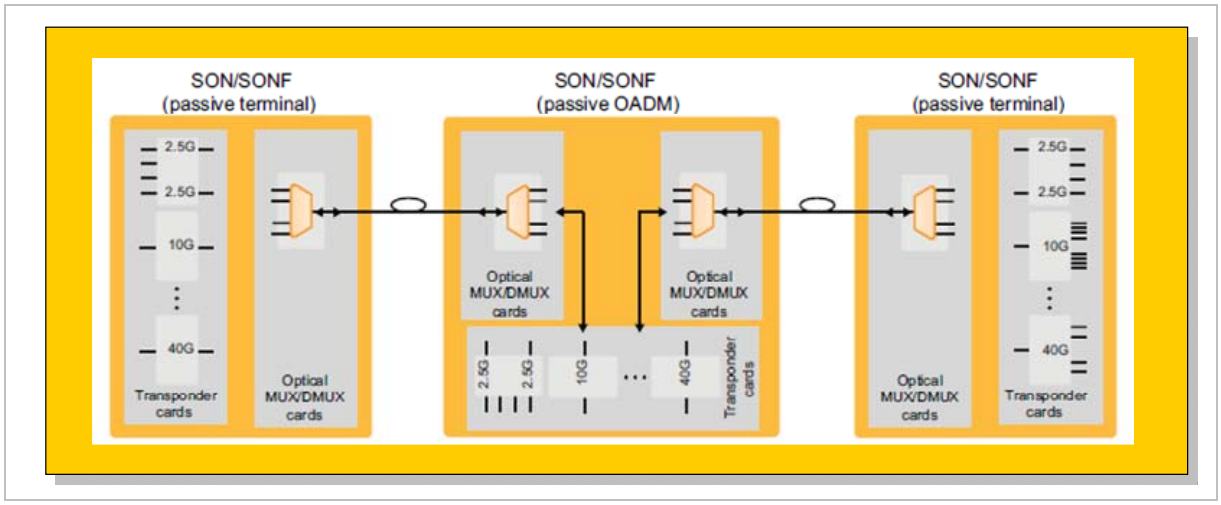

Fig. 151 Example of Pure Passive Terminal and OADM configuration

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Simple point-to-point Applications

For simple point-to-point applications, a passive SON/SONF terminal allows the following distances over a G.652 fiber with the SURPASS hiT 7300 transponder cards:

- Up to 60 km for 40 optical 2.5 Gbit/s channels (70 km with an F40(V)-1 filter card).
- Up to 100 km for 28 optical 2.5 Gbit/s channels.
- Up to 18 km for 12 optical 10 Gbit/s channels.
- Up to 25 km for 8 optical 10 Gbit/s channels.

The exact reach depends on the number of multiplexed channels due to optical filters insertion loss. The reach has to be calculated according to the network application.

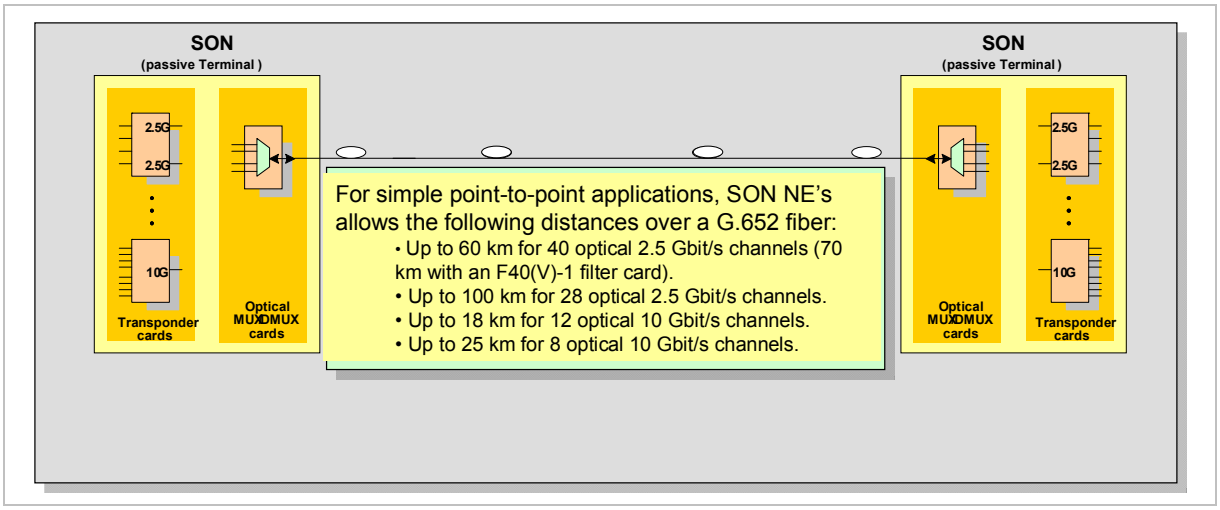
SON
(passive Terminal)
2.5G
2.5G
10G
Transponder cards
Optical MUXDMUX cards
SON
(passive Terminal)
Optical MUXDMUX cards
2.5G
2.5G
10G
Transponder cards
For simple point-to-point applications, SON NE's allows the following distances over a G.652 fiber:
• Up to 60 km for 40 optical 2.5 Gbit/s channels (70 km with an F40(V)-1 filter card).
• Up to 100 km for 28 optical 2.5 Gbit/s channels.
• Up to 18 km for 12 optical 10 Gbit/s channels.
• Up to 25 km for 8 optical 10 Gbit/s channels.

Fig. 152 Simple point-to-point Applications

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3.3.3 Long single span applications

The long single span transmission can be achieved by:

- Interworking of SON and RMH07/1RU/2RU series equipment from MPBC for fiber spans using SSMF or PSCF.
- Using the SURPASS hiT 7300 LASBC-1 and LAMPC-1line amplifiers within SON. Interworking with the MPBC RMH07, 1RU, and 2RU amplification systems provide full support for submarine applications, with a maximum of 80 optical channels over the same fiber. Only point-to-point architectures without optical regenerator sites are supported.

Different configurations with different End of Life (EOL) channel counts are released.

The SON also provides a summary alarm supervision function for the connected MPBC RMH07, 1RU, and 2RU shelf/shelves via its external TIF contacts, so that in case of an alarm of the MPBC RMH07, 1RU, and 2RU amplification system the SON reports a corresponding alarm to the TNMS system indicating the affected services.

TIP
For detailed information about the RMH07, 1RU, and 2RU series, please refer to the MPBC RMH07, 1RU, and 2RU series customer documentation.

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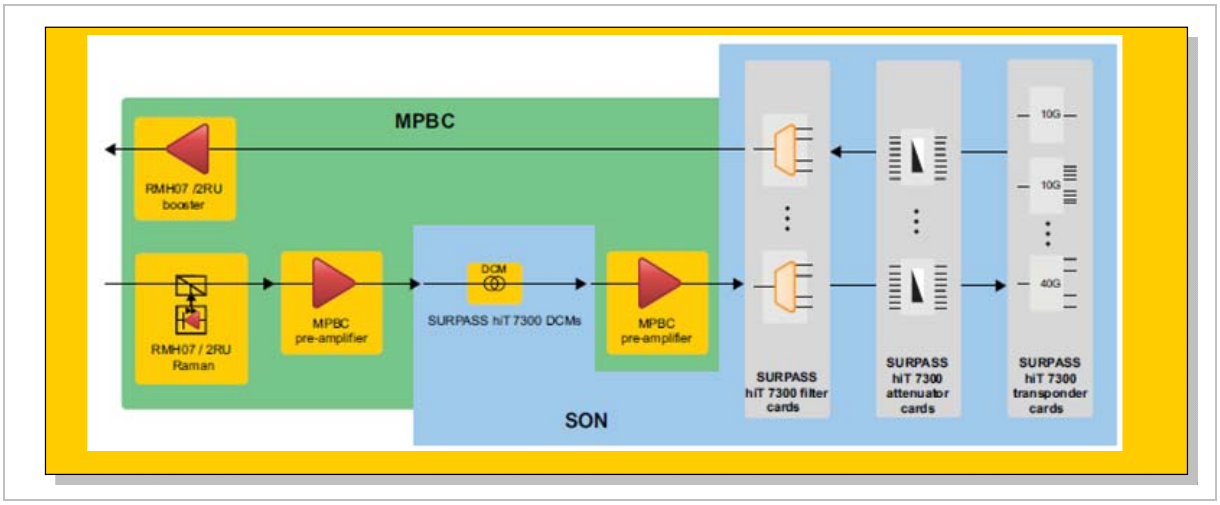

Fig. 153 Long single span applications

Application	Sub-type	Maximum EOL channel count		
		RMH07 P24F booster	RMH07 PY30F booster	RHMH07/1RU P17F booster
w/o RMH07 Raman Fiber Laser	-	16	32	-
w/ RMH07 Raman Fiber Laser	1W	32	32	-
	1.5W	80	64	-
	3W	80	64	-
w/ RMH07 ROPA	-	64	64	-
w/ co and contradirectional pumped Raman amplification	-	-	-	40
w/ codirectional pumped Raman and contradirectional pumped ROPA	-	-	-	40

Fig. 154 Maximum EOL channel count MPBC equipment

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4 CWDM support

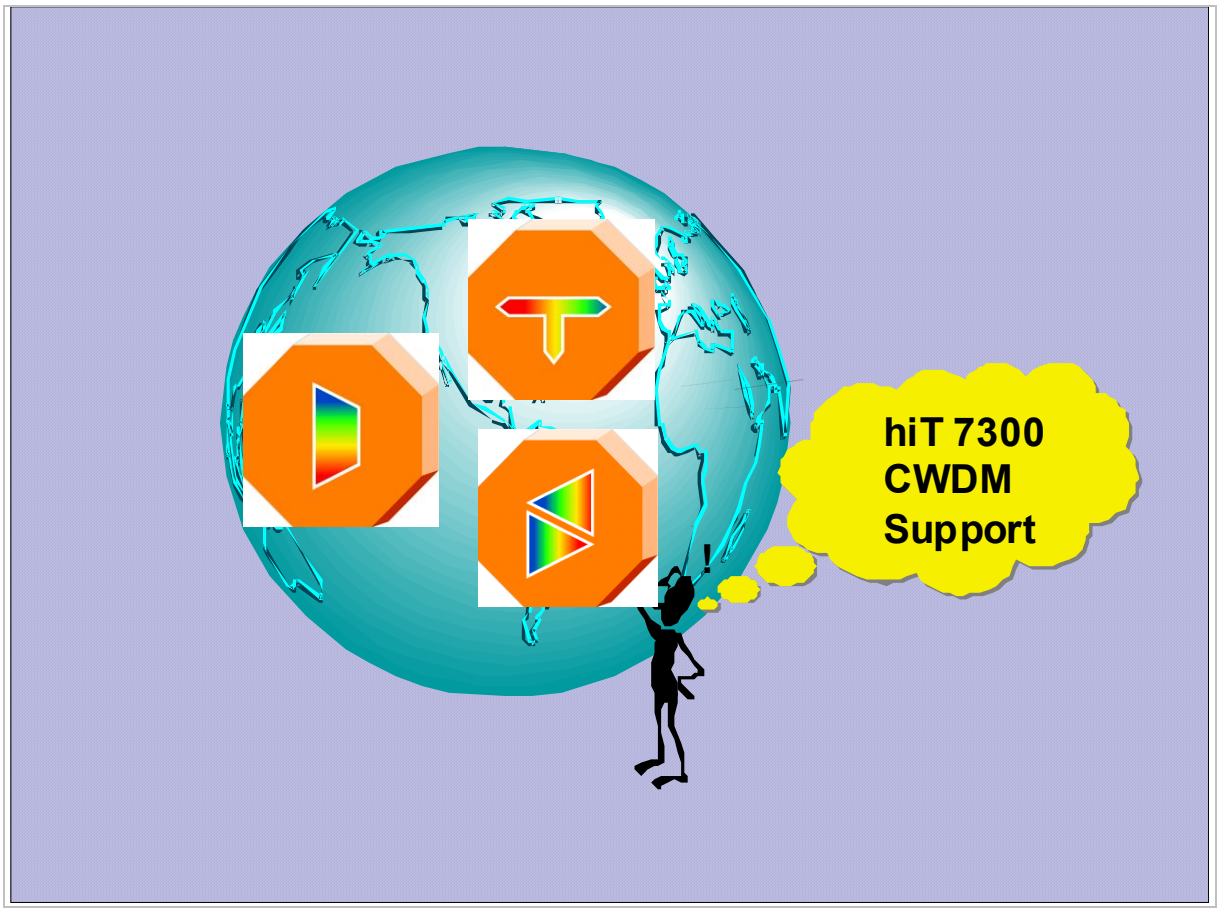

Fig. 155 CWDM Support Types

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The CWDM sub-system allows a very simple and low cost implementation of a passive (no amplification required) optical multiplexing system which can be used for data collection and aggregation of multiple client data from different remote locations within enterprise or small metropolitan networks.

The CWDM sub-system can be applied as a feeder system for a SURPASS hiT7300 NE or can simply be used as a standalone system for interconnection between first mile access equipment and second mile aggregation switches.

The following table lists all the CWDM frequencies supported by the CWDM sub-system:

Wavelengths (nm)	Channel #	Subband	Comments
1271	17	--	introduced in R4.3; channel deployed last due to higher attenuation
1291	18	--	
1311	9	B	introduced in R4.3
1331	10	B	
1351	11	B	
1371	12	B	
1391	13	D	
1411	14	D	
1431	15	D	
1451	16	D	
1471	1	E	introduced in R4.2
1491	2	E	
1511	3	C	
1531	4	C	
1551	5	C	
1571	6	C	
1591	7	E	
1611	8	E	

The CWDM sub-system main features are:

- Support of 18 wavelengths from CWDM grid (according to ITU-T G.694.2) with CWDM interfaces (according to ITU-T G.695).
- Support of 40 DWDM wavelengths and 14 CWDM wavelengths on the same fiber as pure passive system.
- Independent from SURPASS hiT7300 shelf.

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- Mechanical integration either by cascadable CWDM add/drop patch-cord connectors, or by cascadable CWDM filter modules plugged into 1 HU filter pack shelves.
- Compatible with ANSI, hiT7300 ETSI and standard ETSI racks.
- Compliant with Telcordia GR-1209 and GR-1221 for central office conditions.

Supported CWDM frequencies

Wavelengths (nm)	Channel #	Subband	Comments
1271	17	--	introduced in R4.3; channel deployed last due to higher attenuation
1291	18	--	
1311	9	B	introduced in R4.3
1331	10	B	
1351	11	B	
1371	12	B	
1391	13	D	
1411	14	D	
1431	15	D	
1451	16	D	
1471	1	E	introduced in R4.2
1491	2	E	
1511	3	C	
1531	4	C	
1551	5	C	
1571	6	C	
1591	7	E	
1611	8	E	

Fig. 156 Supported CWDM frequencies

Supported CWDM frequencies

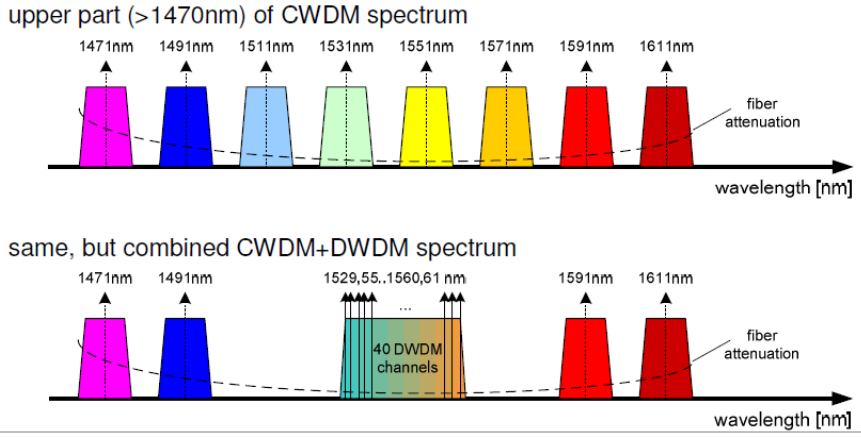

Fig. 157 Supported CWDM frequencies

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4.1 Passive CWDM Filter Pack Solutions

The following pluggable passive CWDM filter modules are available for filter-pack shelves:

- bidirectional single-channel CWDM add/drop modules FC01MDUP-1/n (n=1..8) with upgrade port
  the mechanical height of this module is 1/2 HU, up to 4 such modules can be plugged into a filter-pack shelf
- bidirectional 4-channel CWDM add/drop module FC04MDUP-1/E for the edge CWDM channels (i.e. channels 1,2,7,8) with in-service upgrade port for the center CWDM channels or in-service future (R4.2) upgrade with DWDM channels
  height of this module is 1 HU, up to 2 such modules can be plugged into a filter-pack shelf
- bidirectional 4-channel CWDM add/drop module FC04MDP-1/C for the center CWDM channels (i.e. channels 3,4,5,6)
  the mechanical height of this module is 1 HU, up to 2 such modules can be plugged into a filter-pack shelf
- bidirectional grey-channel (1310nm) band splitter module FC01MDUP-1/0 with upgrade port
  the mechanical height of this module is 1/2 HU

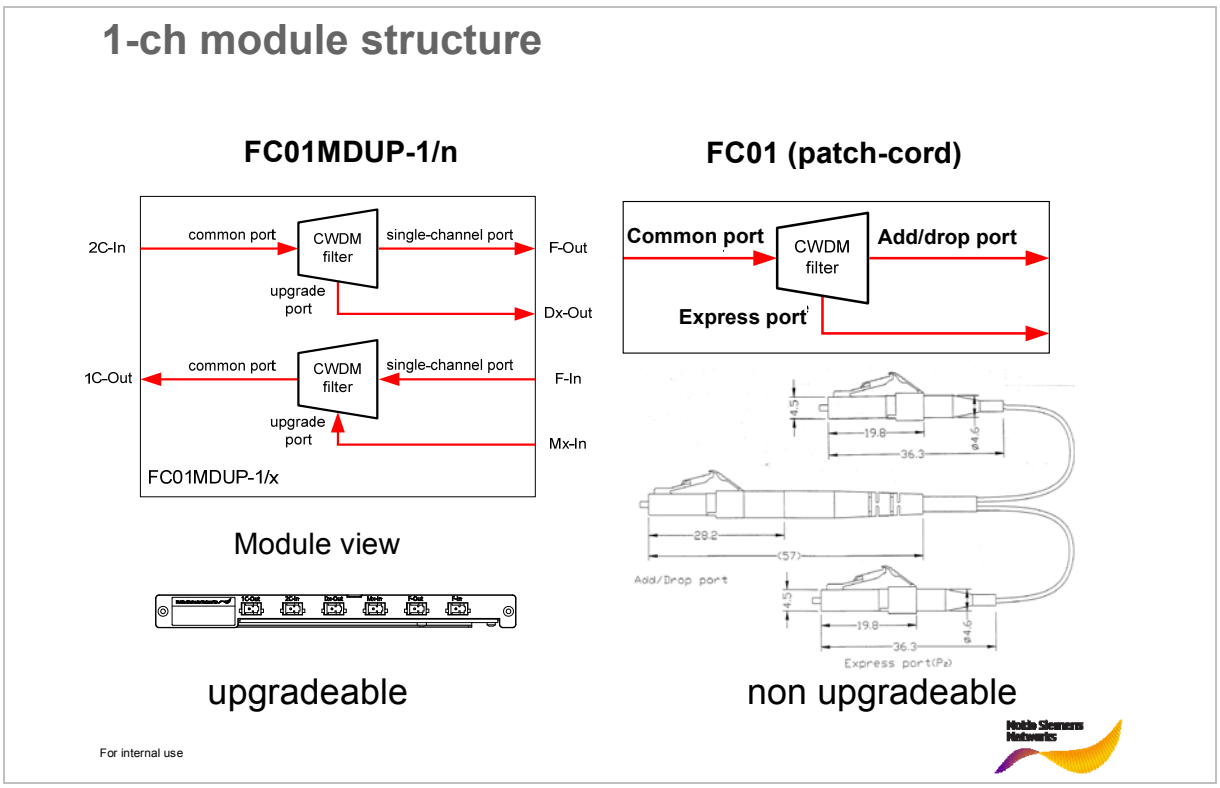

Fig. 158 1ch filter modules

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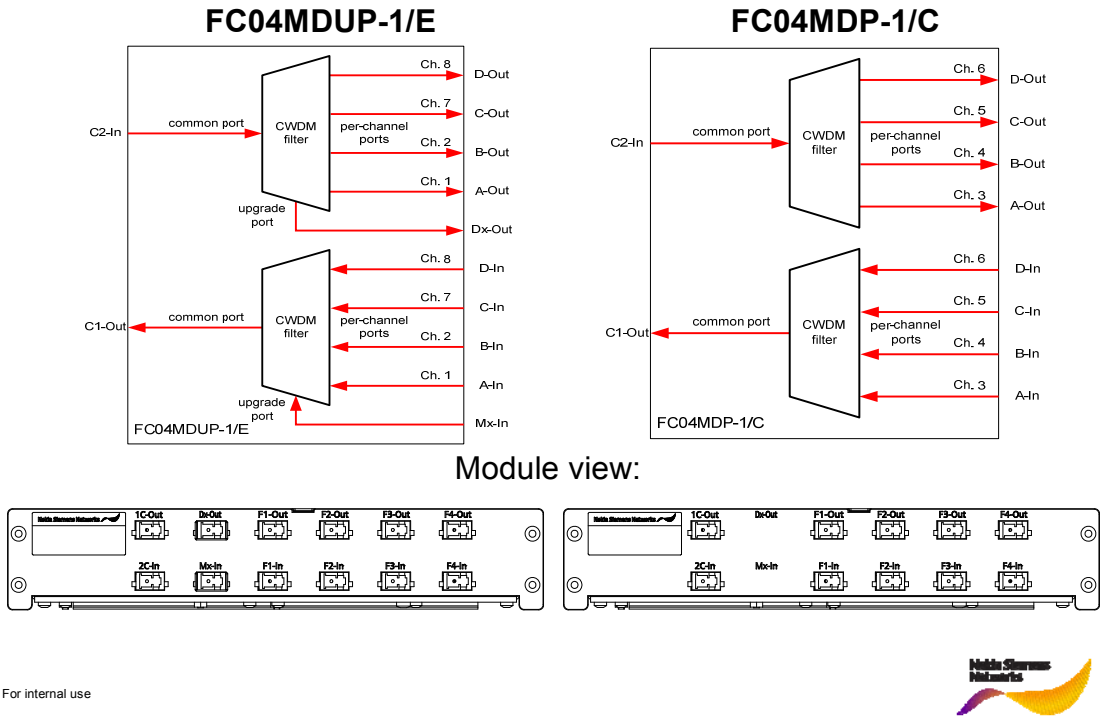
4-ch module structure



For internal use

Fig. 159 4ch filter modules

List of supported filters

FC02SBP-1	Birdirectional CWDM sub-band filter, separator wavelength 1461nm, separating ch 1..8 from 9..18
FC04MDUP-1/D	4 channel filter with upgrade port for 1351/1411/1431/1451nm
FC04MDUP-1/B	4 channel filter with upgrade port for 1311/1331/1371/1391nm
FC01MDUP-1/17	Single channel filter for 1271nm
FC01MDUP-1/18	Single channel filter for 1291nm
FC01MDUP-1/n (n=1..8)	bidirectional single-channel CWDM add/drop
FC04MDUP-1/E	bidirectional 4-channel CWDM add/drop module for the edge CWDM channels (i.e. 1,2,7,8)
FC04MDP-1/C	bidirectional 4-channel CWDM add/drop module for the center CWDM channels (i.e. 3,4,5,6
FC01MDUP-1/0	bidirectional grey-channel (1310nm) band splitter module

hiT DWDM filters are supported in cards that reside within the hiT 7300 shelf types and hiT 7300 passive DWDM and CWDM filter modules are supported within a separate shelf.

For internal use

Fig. 160 CWDM supported filter modules

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4.2 CWDM Filter Architecture

For local access to only a small number (1..3) of CWDM channels, a cascade of single channel filters FC01MDUP-1/n can be used. For access to 4 and up to 8 (9) CWDM channels (optionally including the grey channel) the 4-channel CWDM multiplexer cascade can be used leading to most compact realization and minimum insertion loss. In-service channel upgrades can easily be deployed using the upgrade ports (UP) of the multiplexer modules for cascading of additional modules.

Similarly, add/drop multiplexing schemes can be realized for a small number of channels by cascading of single-channel multiplexing modules FC01MDUP-1/n and using the upgrade port (UP) either for an additional multiplexer stage or for through-passing of traffic between 2 directions of a CWDM transmission line.

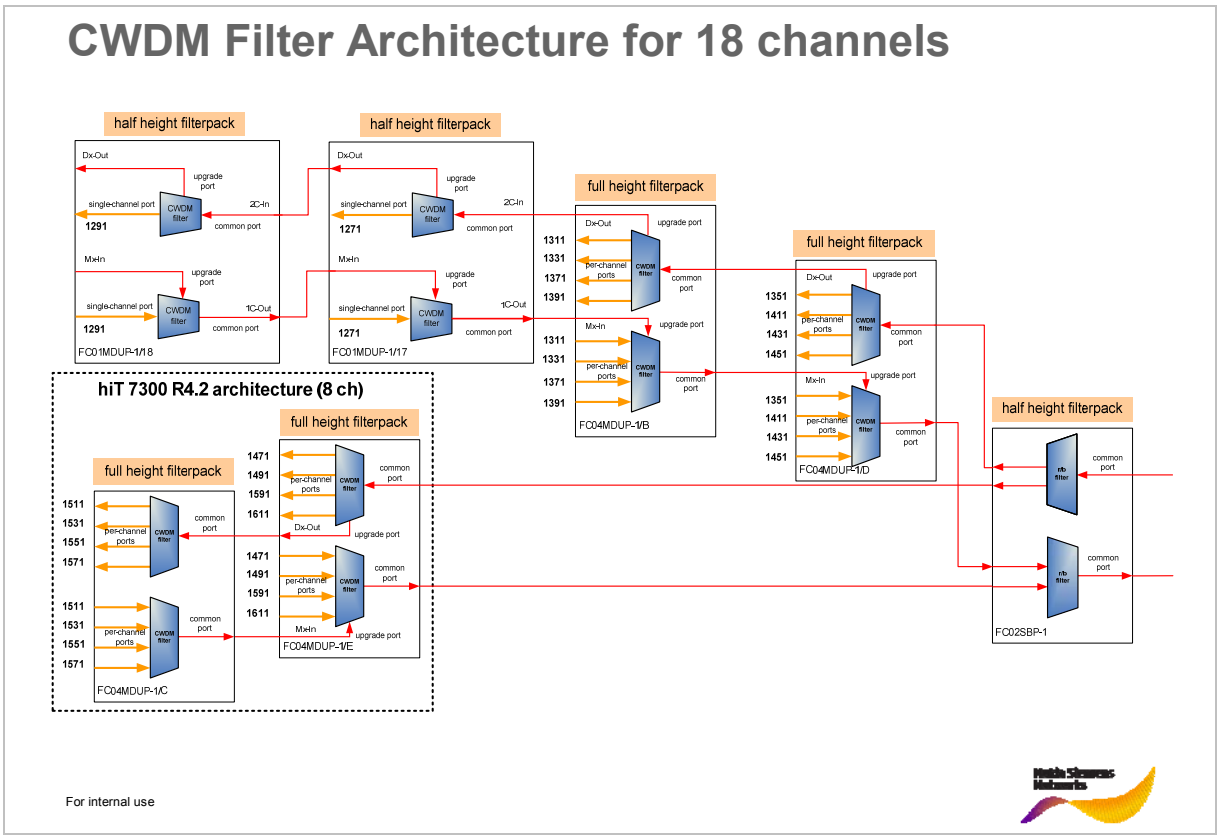

Fig. 161 18 channel CWDM filter architecture

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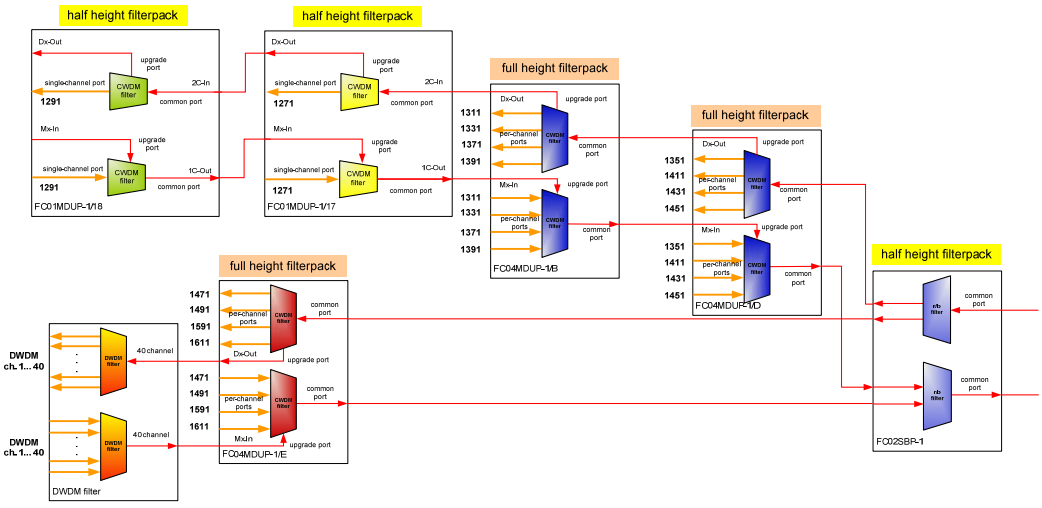
Combination with 14ch CWDM with 40ch DWDM



-DWDM: 100 GHz grid

For internal use

Fig. 162 14 channel CWDM + 40 channel DWDM filter architecture

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4.3 CWDM Topologies

With CWDM, linear point-to-point, point-to-multipoint (collector) and ring topologies are supported as shown in the following overview example.

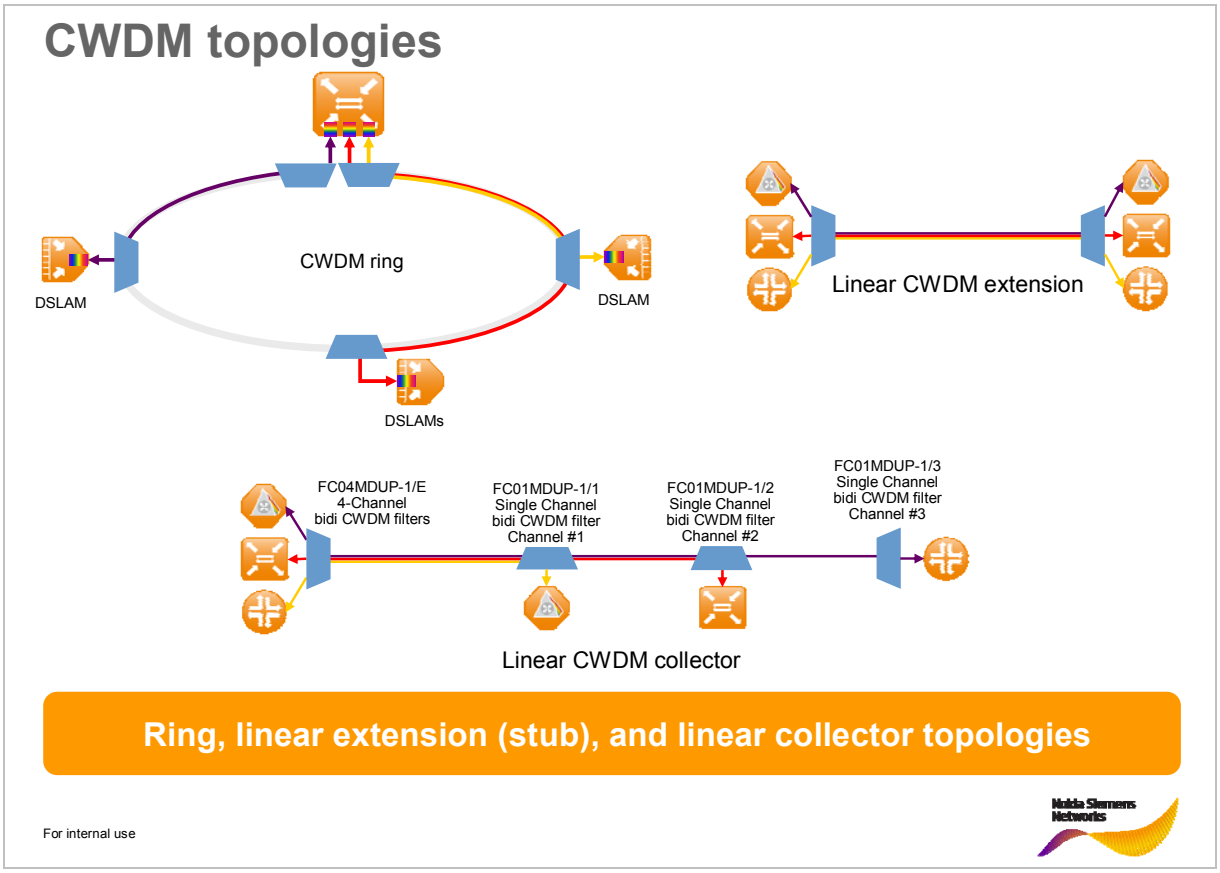

Fig. 163 Supported CWDM topologies

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5 Hardware design

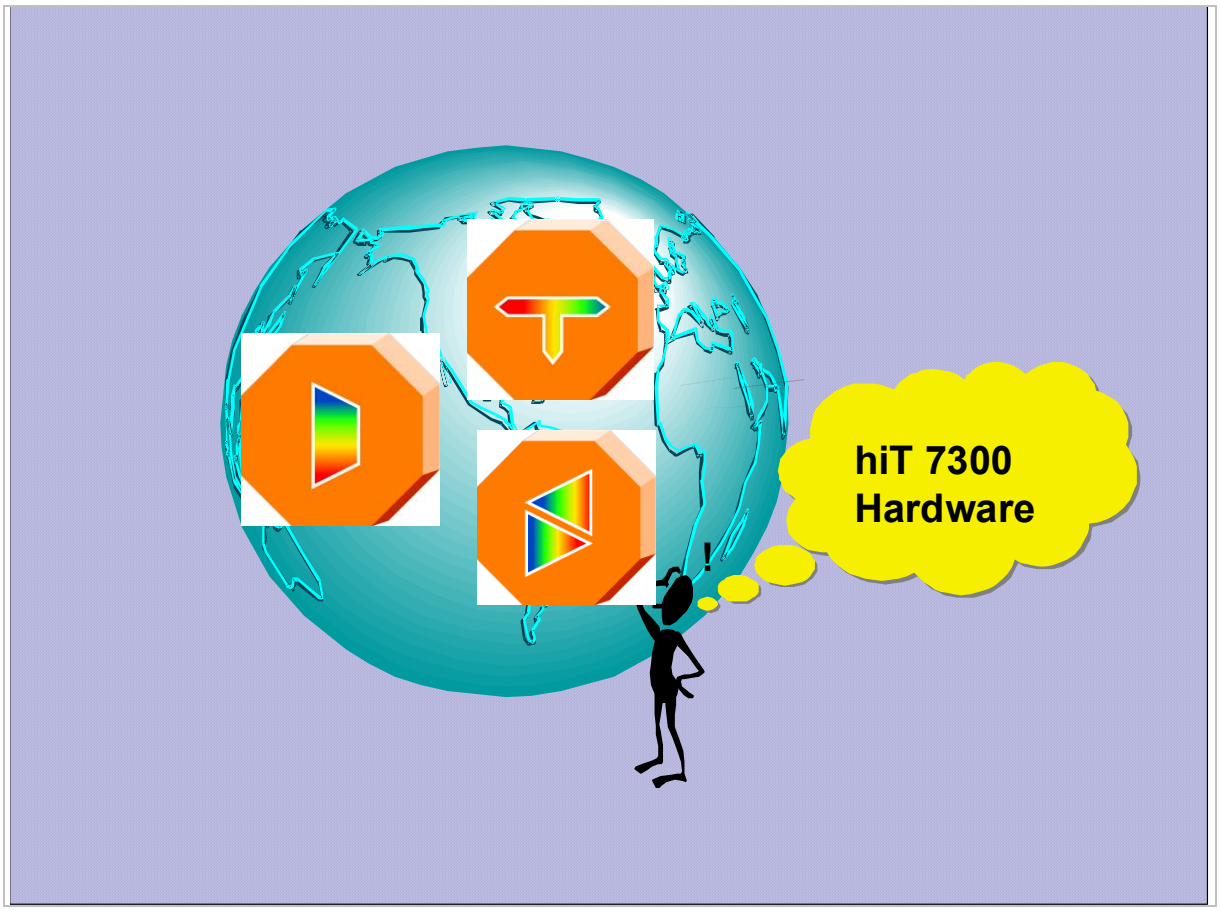

Fig. 164 Hardware

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5.1 hiT7300 racks

The SURPASS hiT7300 rack is designed to meet the demands for environmental compatible product design and the customer demands for minimum space consumption. This requires a mechanical concept with respect to cabling, screening attenuation and power dissipation.

The rack is operated by an AC/DC station converter and a battery 48/60V (ETSI/ANSI), positive grounded. Voltage range is between -40.5 V DC to -75 V DC (nominal voltage -48/-60 V DC).

The racks can be installed individually or in combination. Independent network elements can also be fitted into a rack. The rack is installed and attached below a planar cable shelf or to the wall depending on the local circumstances. To allow this, the rack has a height-adjustable adapter. The lower part of the rack is fixed to the bottom rails with two pins or alternatively screwed to the floor. Height-adjustable feet can compensate for unevenness in the floor of up to 25 mm.

The bottom of the rack is open so as to let in fresh air; likewise the top of the rack is open as an air outlet and cable feed-through.

All electrical lines (connection lines for the telecommunications center, cabling between the sub racks and the rack terminal panel) as well as the FO lines will be routed using the upright rails of the rack and are secured with cable ties.

Rack, sub-rack and modules are grounded by multiple mechanical and electrical connections to the planar shelf (protection earth).

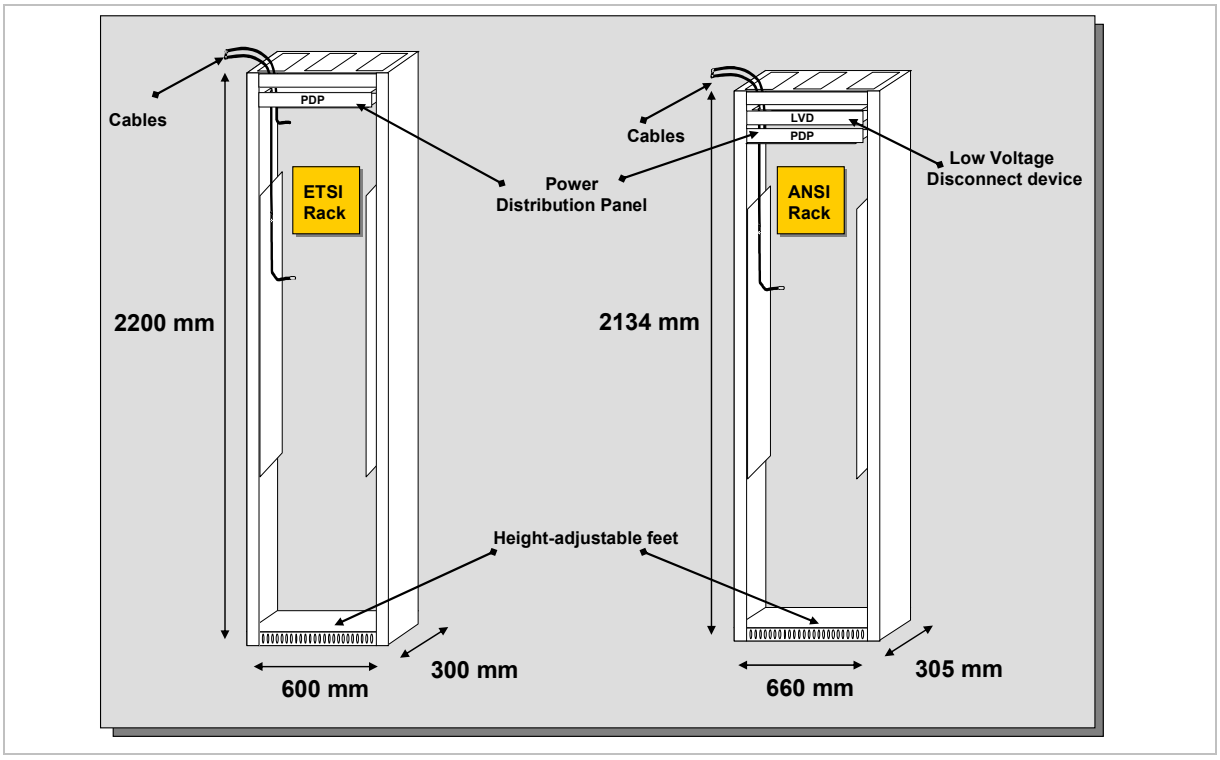

Fig. 165 Design of the SURPASS hiT7300 racks

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5.1.1 hiT7300 Rack Layout

Each rack contains a power distribution panel (PDP) typically mounted near the top. The fuse panel contains sufficient number of fuses (or circuit breakers) to protect all the dual redundant power feeds that are connected to each shelf in the rack. Each rack may be also equipped with an optional Low Voltage Disconnect device (LVD) mounted above the PDP. The LVD monitors the DC voltage feeds supplied to the rack from the battery distribution bay, and will automatically block a power feed whose voltage drops below the lowest allowed limit. Thus, the LVD prevents low voltage from reaching the shelves in the rack. When the voltage feed recovers to the proper operating range, the LVD will automatically unblock it.

Beside the PDP and optionally LVD on top of the rack, up to three single row sub-racks can be mounted in one rack.

Flexible Mechanical Concept

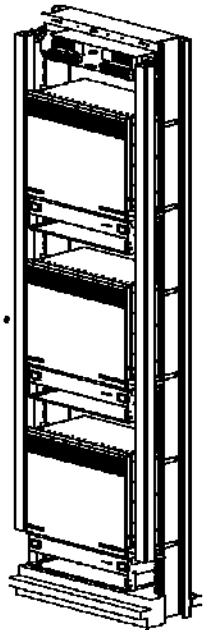
Shelf type

- 510 (H) x 500 (W) x 280 (D) mm³ (ANSI and ETSI racks)
- 15 universal slots for transponders, filters, amplifiers, dispersion compensating modules, protection cards, …
- Each shelf may contain any arbitrary mix of cards
  - no unused, empty rack space
- Shelf also as 19” variant with 13 universal slots

High scalability

- Every node (terminal, repeater, OADM) can start with a single shelf
- Up to three shelves per rack including cable management
- Up to 32 10G-channels (transponders and optical cards) in a single rack
- Network termination unit for OTU1/2, 10GE

Cost optimization for any configuration size



For internal use

Fig. 166 hiT7300 Rack Layout

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5.2 hiT7300 Sub-racks

5.2.1 Standard shelf

The shelves are available as single row shelf in various versions for different applications (ETSI standard, ETSI special, ANSI). All types of shelf are realized as one mechanical concept with plug-in technique and front access of the cards and the fiber connections.

Each shelf consists of:

- Card slots for installing 16 cards (15 standard slots, 1 controller slot).
- Fiber guides to avoid accidental crimping or squeezing of the optical fibers.
- Fan unit with 4 fan packs to cool the shelf's electronic equipment.
- Air filter to protect the electronics and optics from dust and other contaminants.
- Edge protection devices on both sides to avoid fiber bending.
- Shelf connector panel with connectors for power supply, grounding and laser power shutdown network.
- Connector for the grounding of wrist straps.

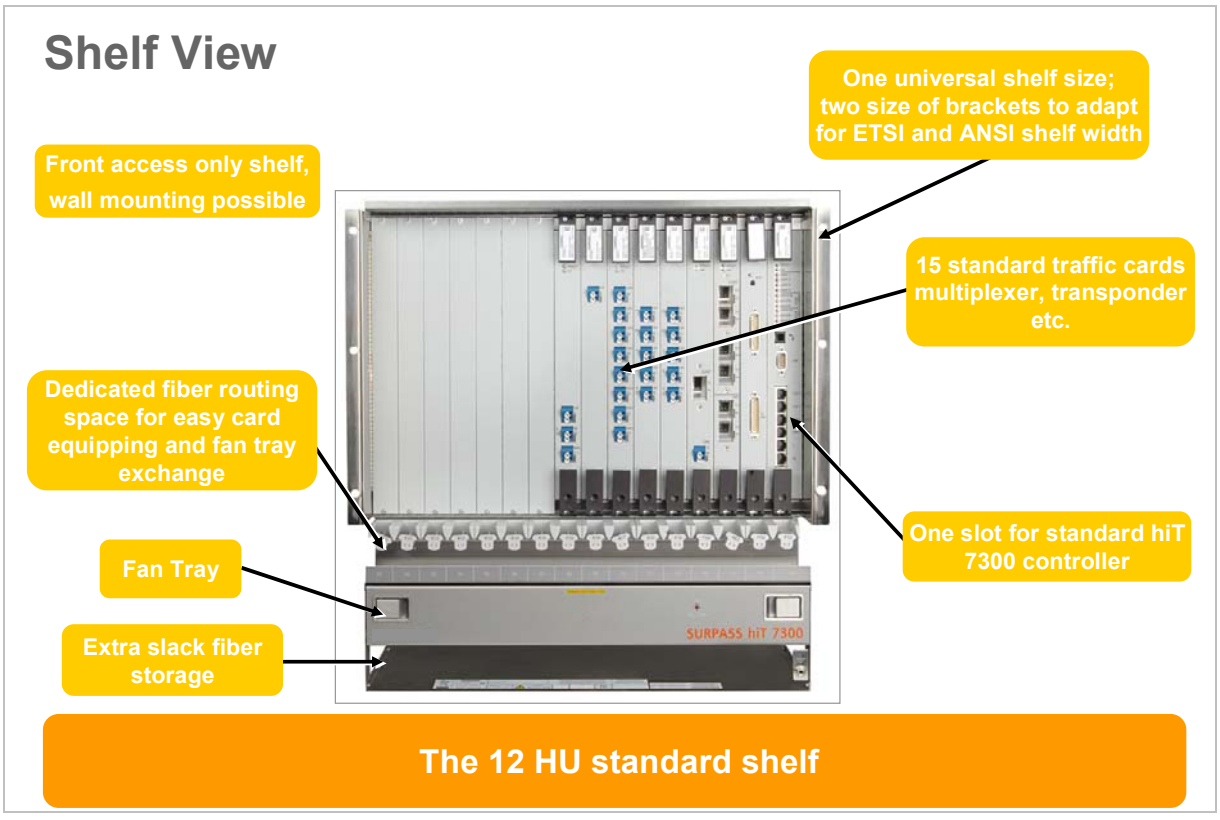
Shelf View
One universal shelf size; two size of brackets to adapt for ETSI and ANSI shelf width
Front access only shelf, wall mounting possible
15 standard traffic cards multiplexer, transponder etc.
Dedicated fiber routing space for easy card equipping and fan tray exchange
One slot for standard hiT 7300 controller
Fan Tray
Extra slack fiber storage
SURPASS hiT 7300
The 12 HU standard shelf

Fig. 167 hiT7300 Sub-racks

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In order to achieve a minimum rack spacing by allowing the outlets of the optical cables to be in front of the rack beams, it is recommended to use the available special ETSI rack for assembling SURPASS hiT7300 shelves.

SURPASS hiT7300 shelves can also be assembled within standard ETSI racks. However, in case of mounting a hiT7300 shelf into a standard ETSI rack, the usable cabling space in front of the rack beams is rather small which leads to cabling limitations for typical ONN applications. Therefore, it is advised to apply standard ETSI rack assembling only in case of OLR applications.

TIP

SURPASS hiT7300 sub-rack can be equipped with the front cover to protect optical cabling against damage (optional, not applicable in combination with rack front door).

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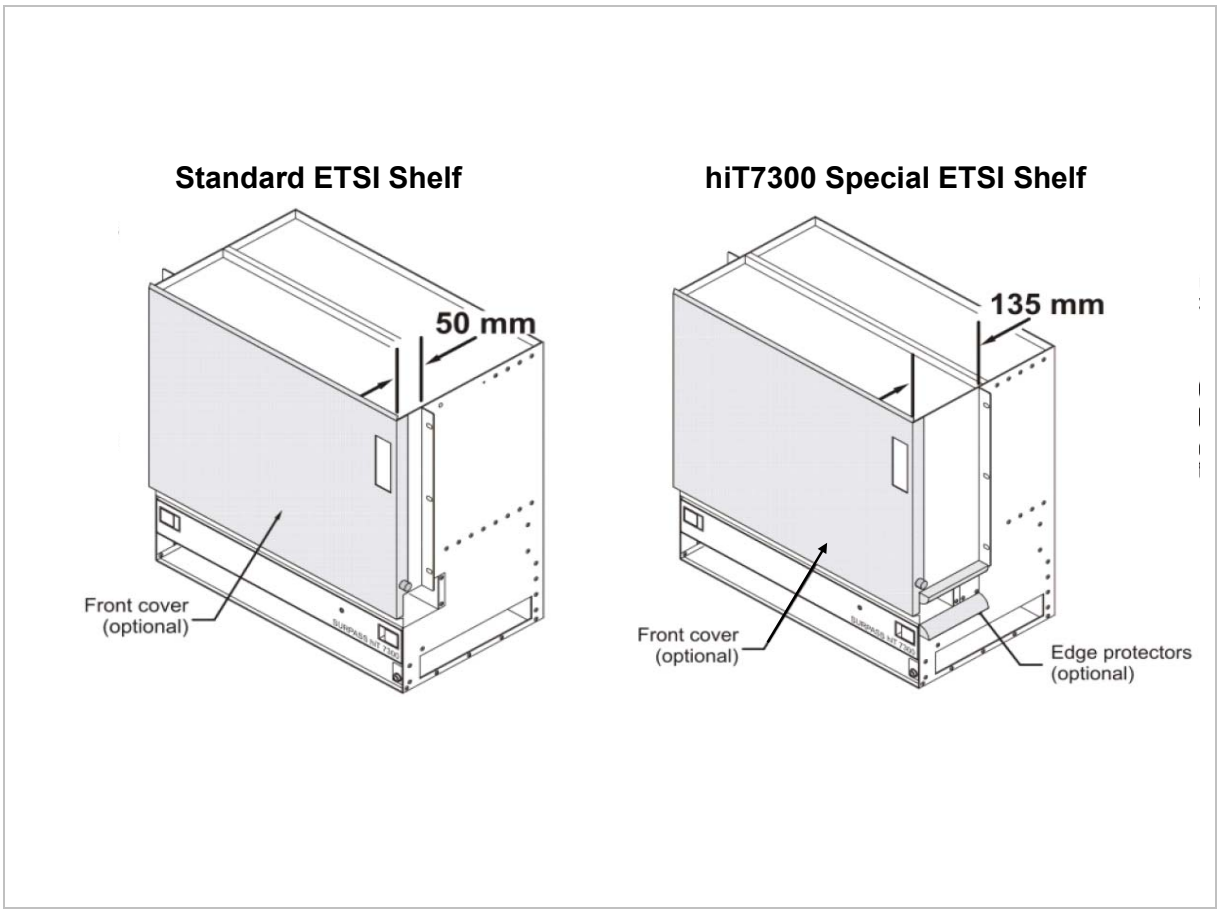

Fig. 168 Standard ETSI and Special ETSI shelves

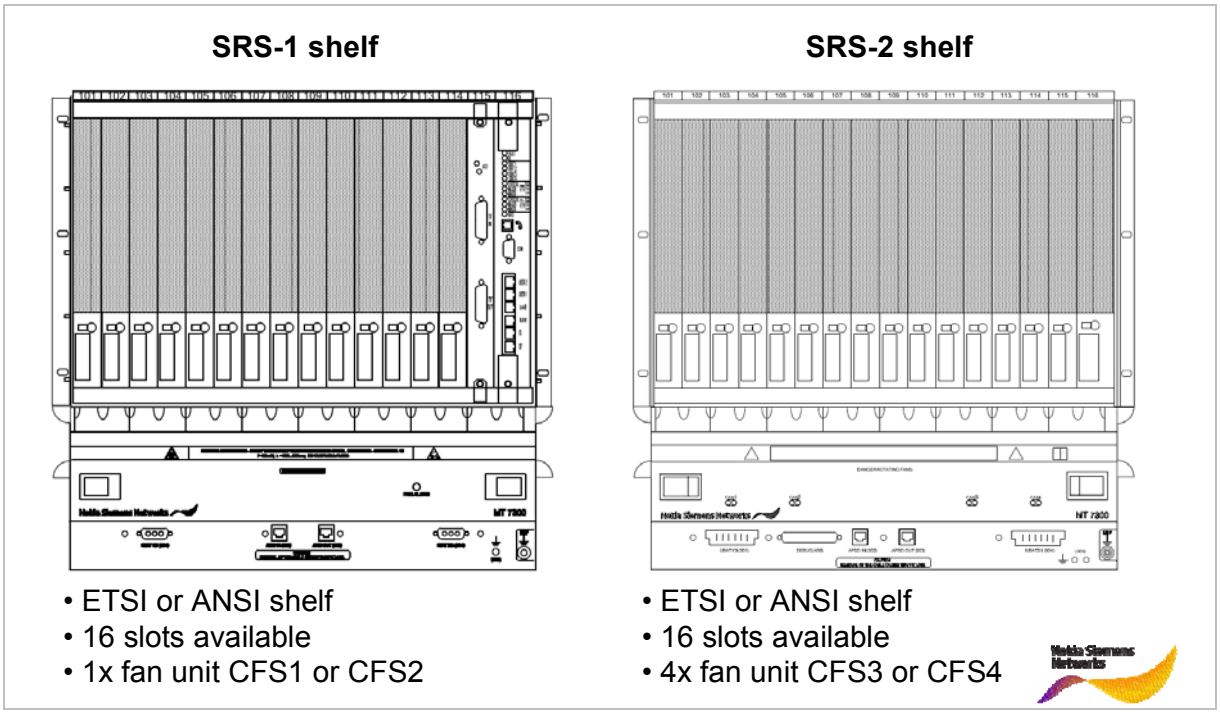
SRS-1 shelf
• ETSI or ANSI shelf
• 16 slots available
• 1x fan unit CFS1 or CFS2
SRS-2 shelf
• ETSI or ANSI shelf
• 16 slots available
• 4x fan unit CFS3 or CFS4

Fig. 169 hiT7300 shelf types

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5.2.2 Flatpack shelf

The SURPASS hiT 7300 also provides a flatpack shelf for small NE installations that require only a few cards, (e.g., remote passive network termination using SONF with one or two transponder cards only).

The flatpack shelf can be mounted into ETSI, ANSI and 19” racks, the material of the flatpack shelf frame is stainless steel.

TIP

The flatpack shelf solution can only be implemented in SONF NE's.

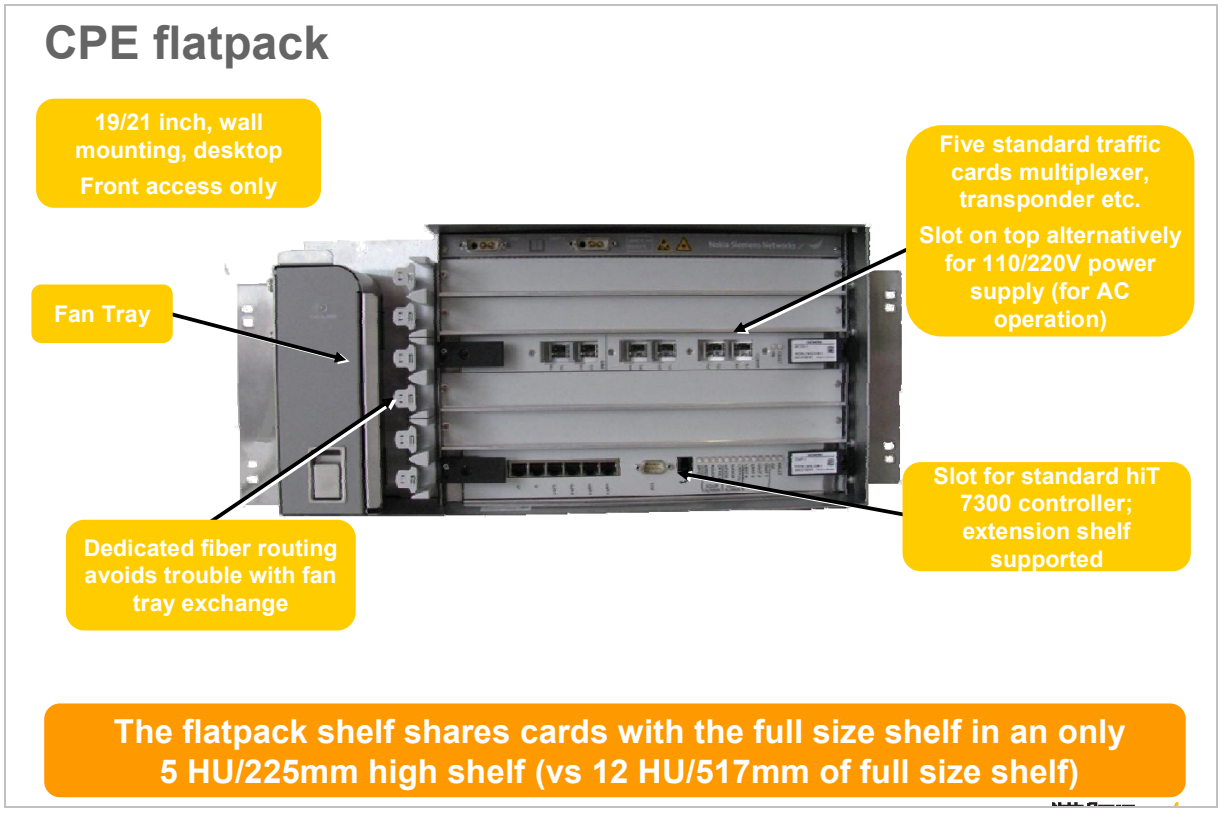
CPE flatpack
19/21 inch, wall mounting, desktop
Front access only
Five standard traffic cards multiplexer, transponder etc.
Slot on top alternatively for 110/220V power supply (for AC operation)
Fan Tray
Slot for standard hiT 7300 controller; extension shelf supported
Dedicated fiber routing avoids trouble with fan tray exchange
The flatpack shelf shares cards with the full size shelf in an only 5 HU/225mm high shelf (vs 12 HU/517mm of full size shelf)

Fig. 170

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5.2.3 19" shelf

The SURPASS hiT 7300 also provides a 19 inch shelf for installations in computer racks that require a high amount of cards.

The 19" shelf can be mounted into 19” racks, the material of the 19" shelf frame is stainless steel.

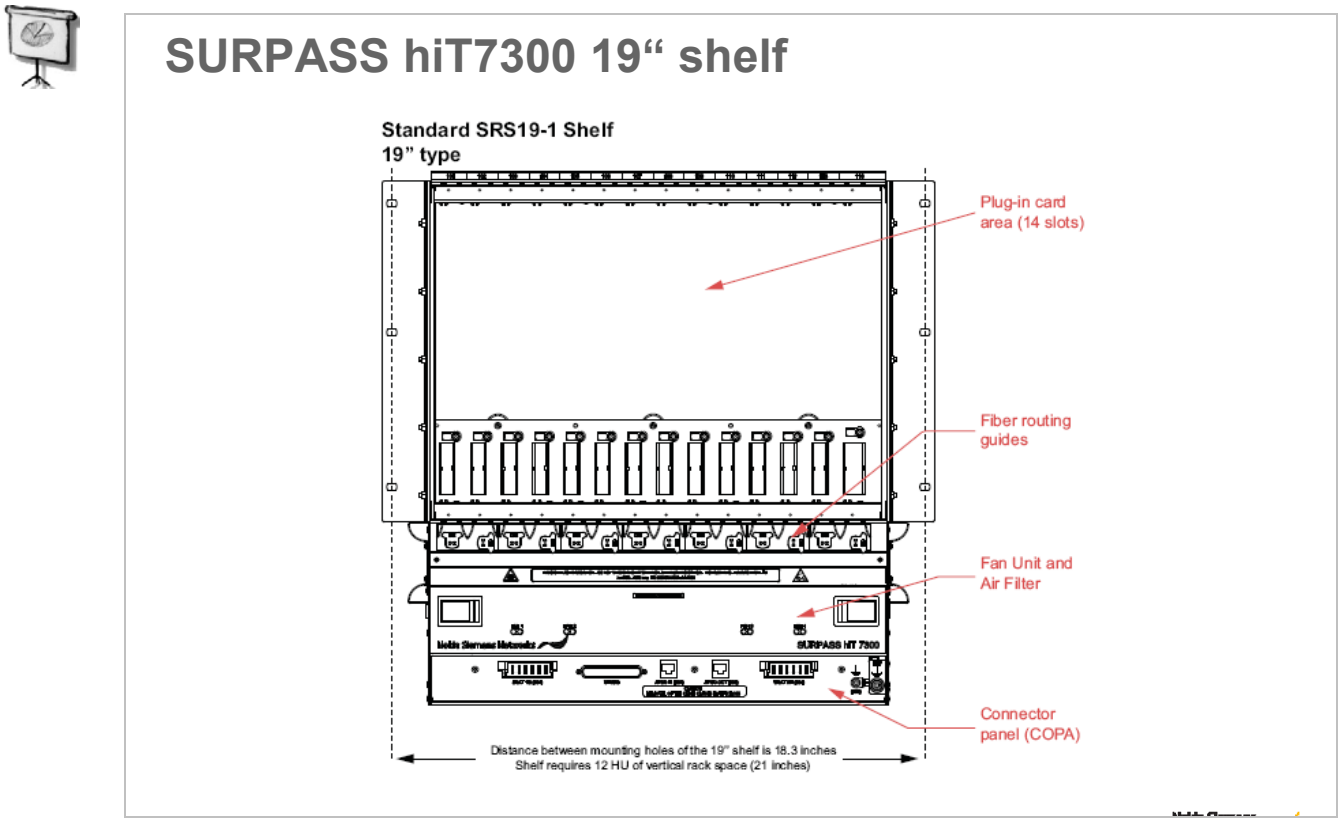
SURPASS hiT7300 19“ shelf
Standard SRS19-1 Shelf
19” type
Plug-in card area (14 slots)
Fiber routing guides
Fan Unit and Air Filter
Connector panel (COPA)
Distance between mounting holes of the 19" shelf is 18.3 inches
Shelf requires 12 HU of vertical rack space (21 inches)

Fig. 171 19" shelf

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5.2.4 DCM Shelf

The DCM shelf is needed in cases where external dispersion compensation modules are required for dispersion compensation. The DCM's are inserted in drawers which can be pulled out of the shelf. The drawers are fixed via telescope rails to the frame of the DCM shelf. The drawers are provided with locks in order to prevent unintentional opening. The drawers can be pulled out without using any special tool.

One DCM shelf is capable for plugging of 4 DCMs of height 1HU or 2 DCMs of height 2HU, respectively.

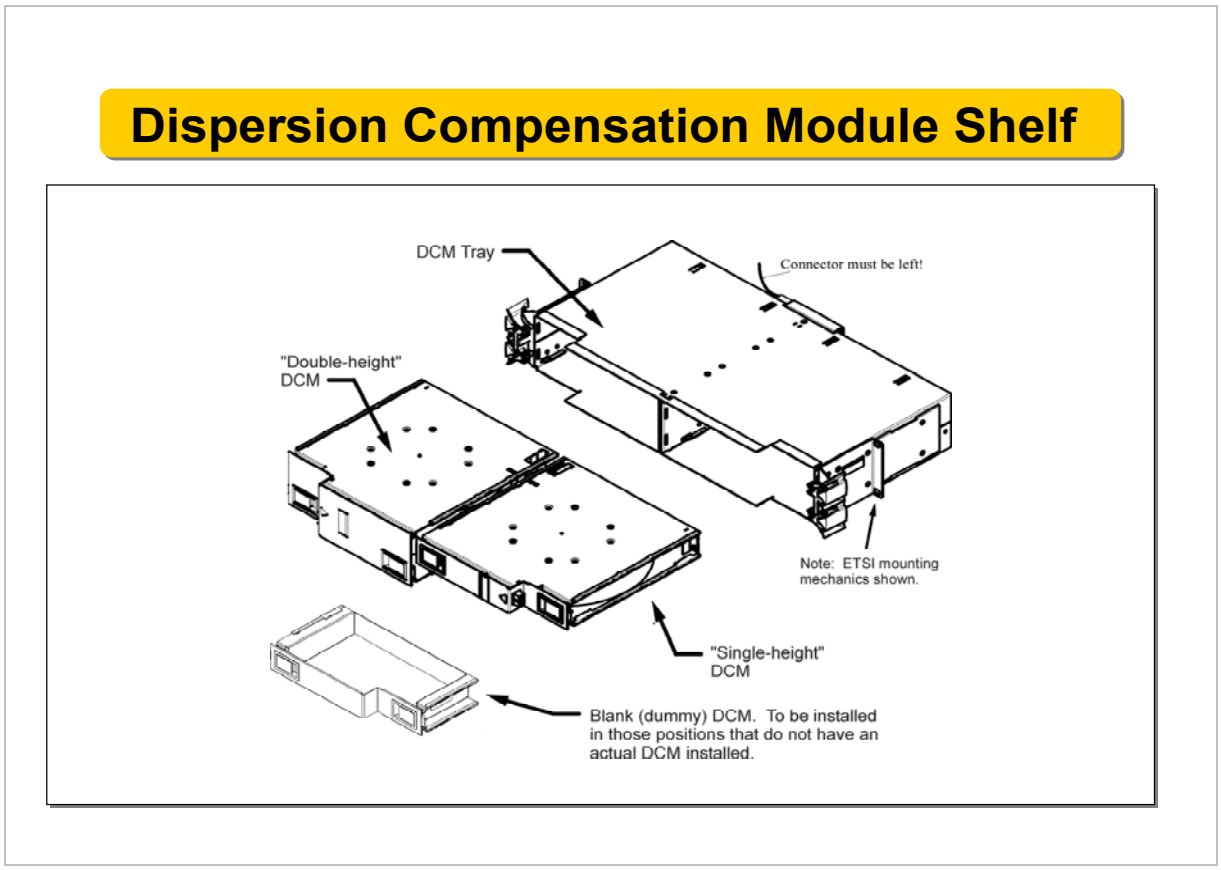
Dispersion Compensation Module Shelf
DCM Tray
Connector must be left!
"Double-height" DCM
Note: ETSI mounting mechanics shown.
"Single-height" DCM
Blank (dummy) DCM. To be installed in those positions that do not have an actual DCM installed.

Fig. 172

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5.2.5 Shelf fan unit and air filter

The shelf fan unit and air filter are mounted in the middle of the shelf, between the fiber routing guides and the connector panel.

Fan unit:

Each shelf is equipped with a fan unit that provides cooling airflow for the cards. The fan unit is held securely in place by hand-operated latches. The operating status of the four individual fans inside the unit is monitored. Detection of a fault condition will raise the appropriate system alarm and light the LED on the front of the fan unit.

Air filter:

The fan unit contains a one-piece replaceable air filter element to protect the shelf from ingesting environmental dust or other airborne contaminants. Air filter replacement must be treated as a periodic maintenance procedure to ensure that the fans are able to sustain optimum shelf operating temperature.

WARNING
An excessively dirty air filter will reduce cooling airflow.

WARNING
Always provide adequate air cooling. A populated shelf must not be operated without the fan unit for more than 10 minutes.

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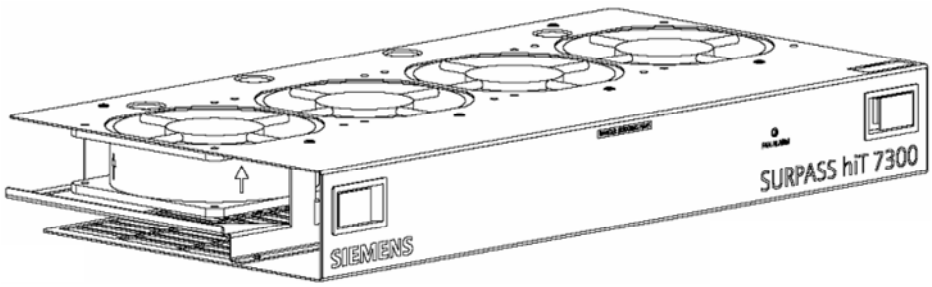

- One fan drawer per shelf with a slide-in fan unit
- The fan unit is equipped with four fans and an air filter
- Front access: the fan unit can be extracted out of the subrack without using special tools
- The fans will stop within a few seconds after removing the fan unit from the drawer
- The system will be thermally operational under the following condition: one single fan within the fan unit fails at the maximum air temperature (55° C)
- A red LED indicates the operating status of the fans

Fig. 173 SURPASS hiT7300 Fan unit

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5.2.6 Connector Panel

The connector panel (COPA) is placed inside the shielded room at the bottom edge of the SURPASS hiT7300 sub-rack. The external management and power supply connectors of the sub-rack are centralized on its connector panel. There is also EMI filter elements.

The COPA connectors are listed in the following table:

Connector Name	Connector Type	Remarks
UBAT 1/3; UBAT 2/4	3W3 D-Sub	For connection of shelf DC operating voltage (redundant power feeds from the rack Fuse Panel)
APSD IN; ASPD OUT	8-pin RJ45	Input and output connectors for the amplifier card Automatic Power Shutdown (APSD) bus. APSD signaling is daisy-chained from shelf -to-shelf via cable using these connectors
GND	M4 threaded stud	Shelf grounding cable must be attached here

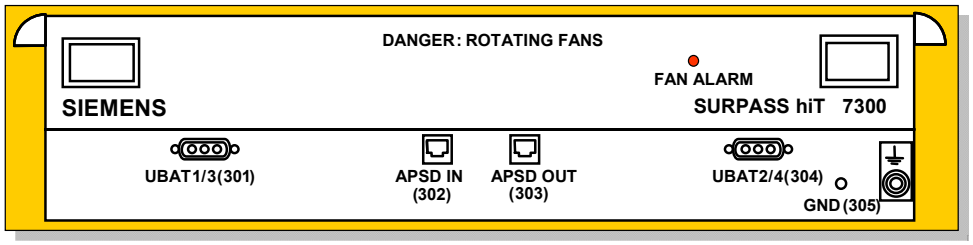

Fig. 174 Connector panel (COPA)

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5.2.7 Cable outlet

In order to minimize the rack spacing of the sub-racks, the outlets of the optical cables is available in front of the rack beams. Each sub-rack has a cable outlet which is placed below the screened room of the sub-rack. All cables can be bent over defined radius (radius of bend = 30 mm) in order to avoid any problems with transmission of the optical signals.

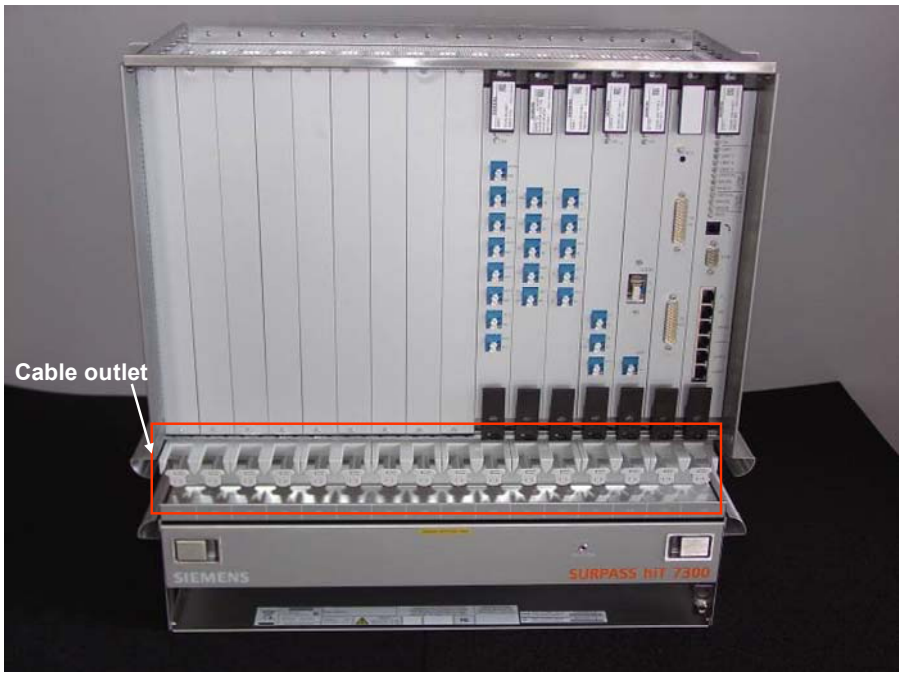

Fig. 175 Cable outlet

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5.3 RMH07 series Sub-Rack

The RMH07 sub-rack has been designed to safely and securely fit into ETSI standard racks (600mm width by 300mm depth). A spacing clearance of 200mm or more must be left on top the RMH equipment to provide proper heat exhaust. No spacing clearance is required at the bottom of the equipment.

A maximum of two RMH07 sub-racks can be installed in a 2200mm ETSI rack. Allocating 0.80 m of vertical rack space to each RMH07, the remaining of the rack space will be used by the power distribution and management monitoring equipment. The RMH07 sub-rack has three compartments – the cable shelf, card shelf and fan shelf.

The fan shelf accommodates up to three Environmental Control Units (ECU). The fan shelf provides power and monitor signal connections for the ECU's via the backplane.

The card shelf contains the main electronic components of the RMH07. The card shelf compartment is protected with a removable hinged door. There are 23 slots in the card shelf section of the RMH07 with a slot spacing of 20 mm (0.79”). Forced air is circulated from bottom to top via the ventilated card guide. The card shelf provides power, control and monitor signal connections for the PIU via the backplane. Encoding keys prohibit the user from inserting a card in the wrong location.

All external electrical and optical connections to and from the RMH07 sub-rack are made through the cable shelf compartment. Electrical connections are made to/from the backplane, whereas the optical connections are through the fiber fingers between the card shelf and the cable shelf compartments.

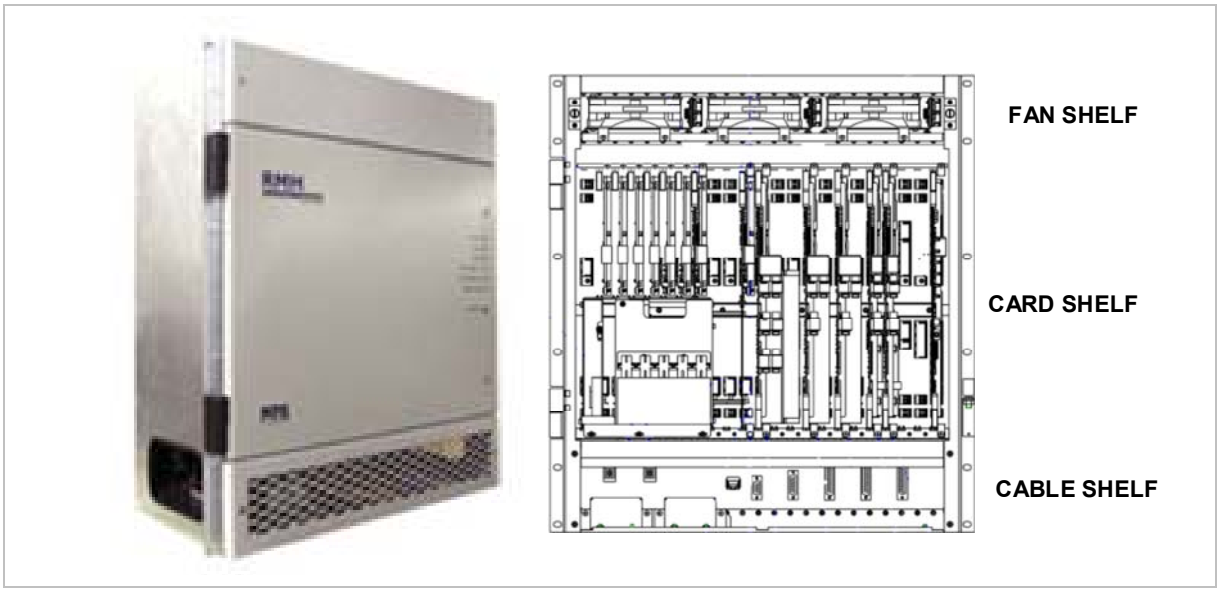

Fig. 176 RMH07 series Sub-Rack

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RMH07 typical configurations are shown in the following figure:

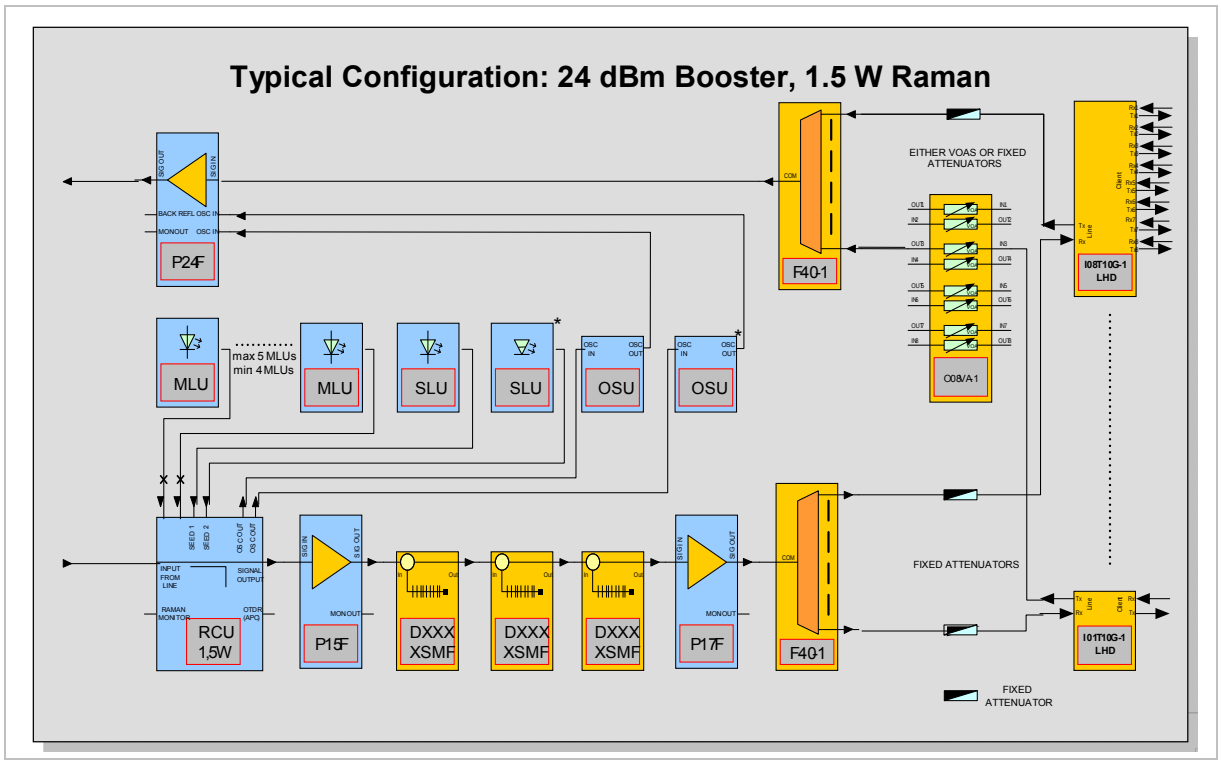

Fig. 177 RMH07 typical configuration_1

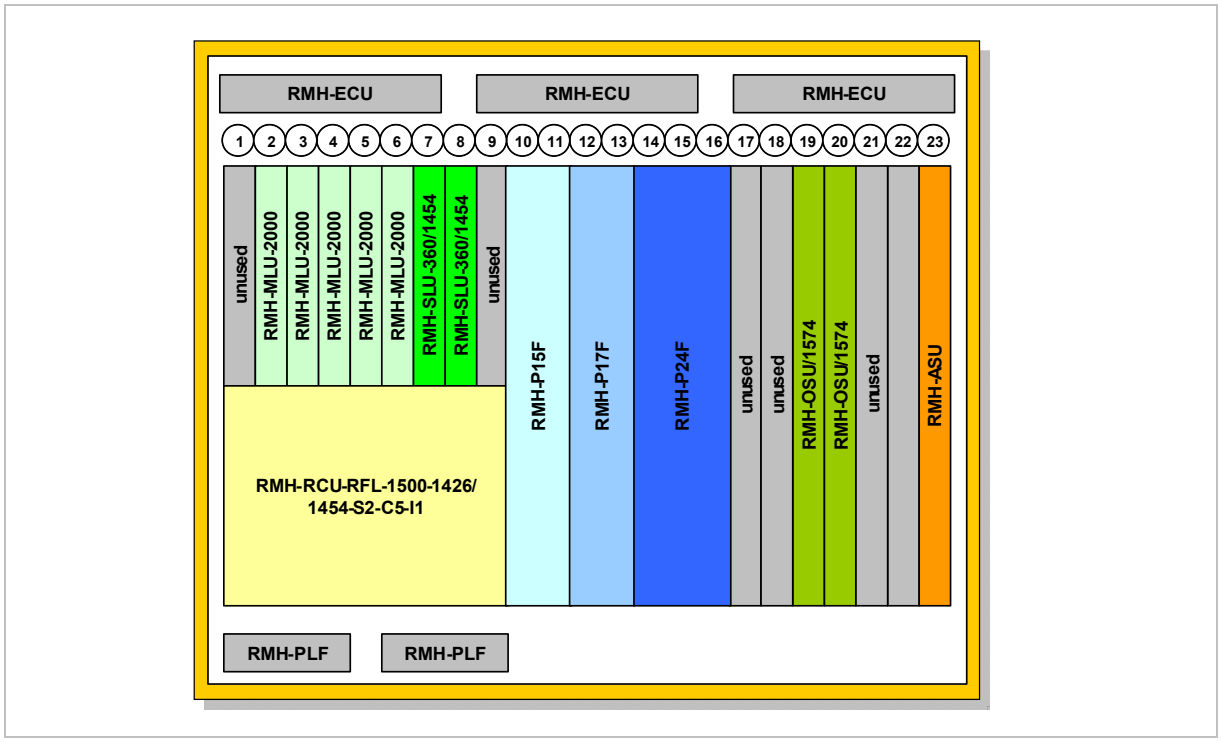

Fig. 178 RMH07 typical configuration_2

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5.4 Mechanical design of modules

5.4.1 Basic card design

Each card consists of a multi-layer PCB with a surrounding ESD grounding frame and a face plate. The components are fitted on both sides of the PCB.

The SIPAC connectors at the rear of the card as well as the corresponding SIPAC connectors on the sub-rack backplane are fitted with mechanical card coding elements. Each card can only be fully inserted into a sub-rack slot that is suitable for this card, so that fundamental sub-rack equipping errors (which possibly might cause damages or extensive malfunctions) are impossible. These mechanical coding elements also ensure the proper centering and grounding of the card in the sub-rack. All cards have insertion and removal aids that fit into the holes of the card guides in the sub-rack. No special tools are necessary for inserting or extracting the cards.

WARNING
Note that installing cards requires slow and careful handling. Never apply excessive force!

Cards comprise all devices PCB (printed circuit boards) which can be installed by a simple plug-in procedure. Each card can be fixed with captive screws on the top and bottom card levers. The grounding pins of the SIPAC connectors are pre-mating, so that they first of all establish the ground connection, when the card is being inserted into the sub-rack.

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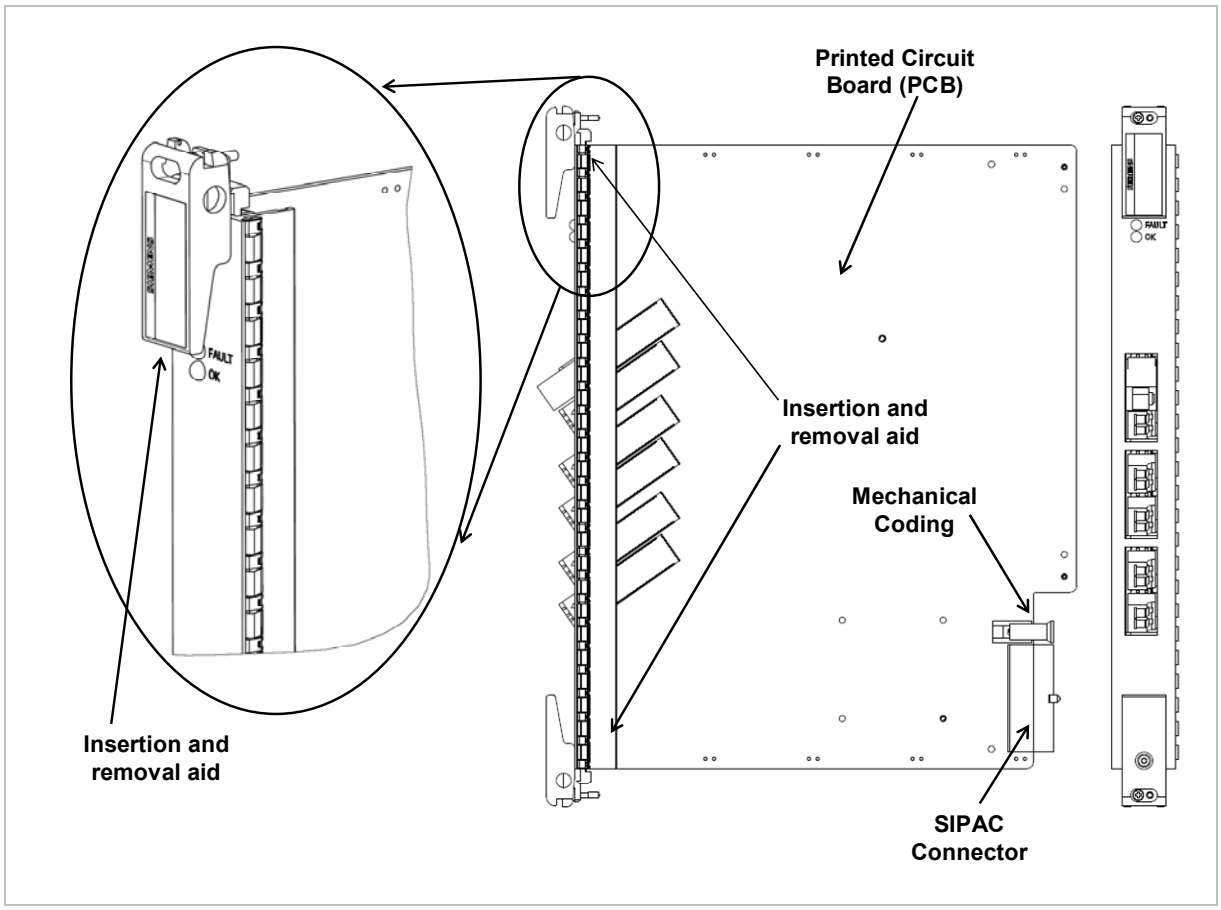

Fig. 179 Basic card design

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5.4.2 Card faceplate LED's

Each "active" card, i.e., those that contain an on-board processor, has a green OK LED and a red Fault LED on its faceplate that indicates card status. "Passive" cards (e.g., Filter cards) do not have any LED's.

The following information can be obtained from the "OK" LED and from the "Fault" LED:

Element	Color	Explanation
OK LED	Green	When the OK LED is on, it indicates that the card is powered, operating fault-free, and is capable of carrying traffic
Fault LED	Red	When the Fault LED is on, it indicates that the card has detected an on-board hardware or software failure. When the failure condition clears, the Fault LED is extinguished. The Fault LED is powered by a backplane power bus, ensuring that a card can light its Fault LED even if its own on-board power supply fails

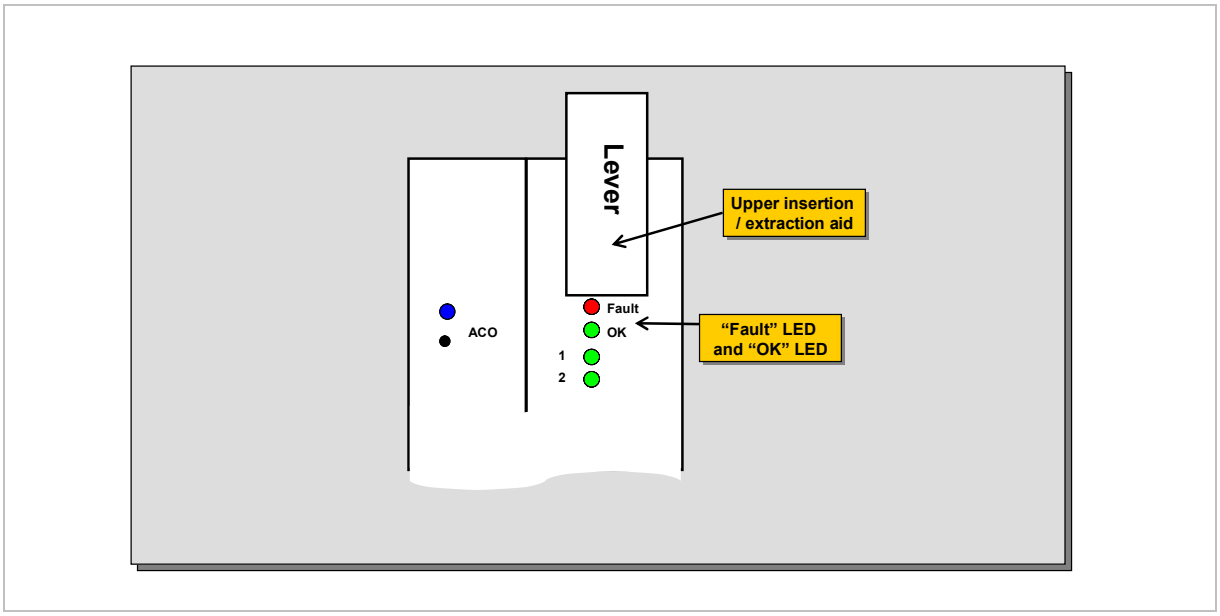

Fig. 180 Card faceplate LED's

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5.4.3 Cards and optical connectors labeling

The visible surfaces of the insertion and removal aids are used for card identifying labels.

The front panel of an optical card is either fitted with optical fiber connectors or with SFP modules. The available fiber connector variants, depending on the card types, are listed in TED.

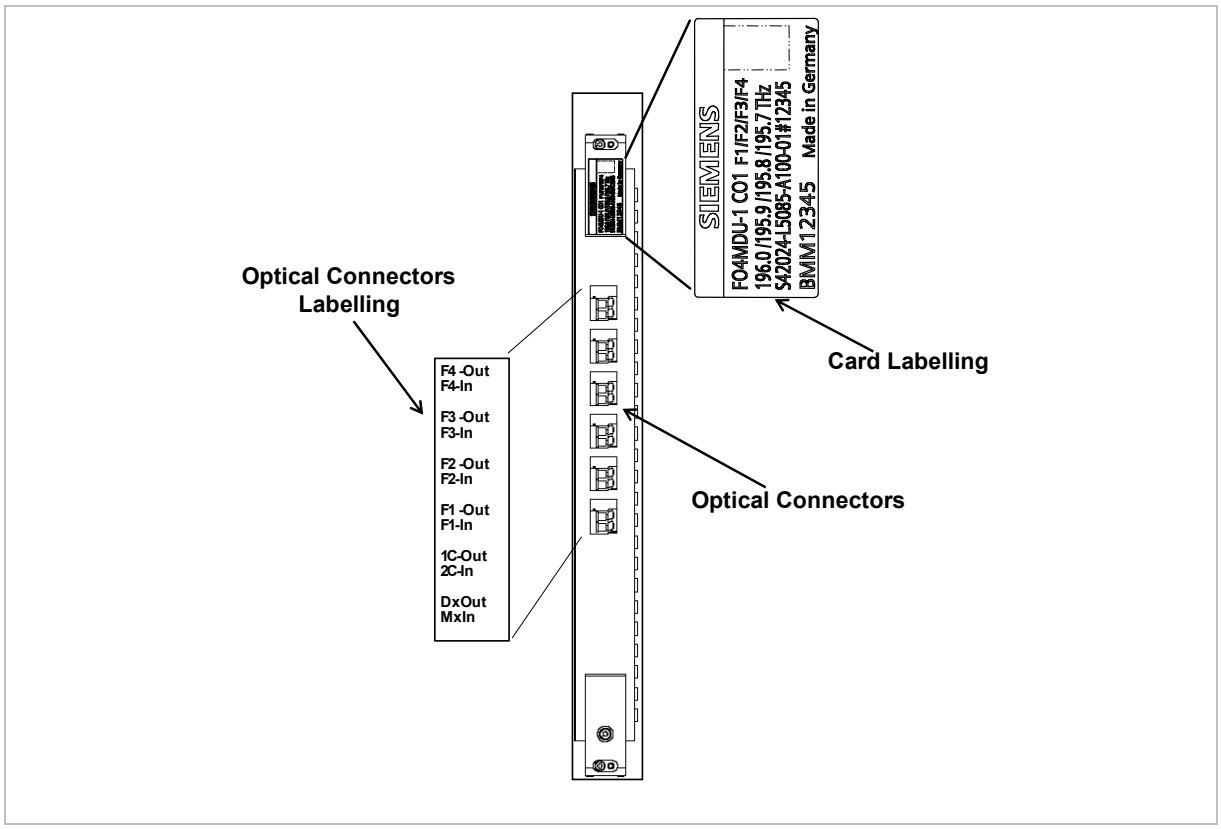

Fig. 181 Example of the cards and optical connectors labeling

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5.5 SURPASS hiT7300 optical cabling

SURPASS hiT7300 equipment operates at high laser power levels. Use extreme caution when connecting or disconnecting fiber, since high optical power levels can be present at card connectors or fiber ends.

WARNING
Never look directly into the end of a fiber, patchcord, fiber pigtail or card connector until you are sure that no light is present. Permanent eye damage or blindness can result if exposed to such optical power levels - even for extremely short durations.

In order to avoid cable damage when routing the optical connections, the following fiber guiding parts of the system have to be used:

- Fiber duct: Supports safe fiber routing from rack to rack.
- Edge protection: Avoids bending of optical fiber running from or to the fiber guides of a shelf (shelf-to-shelf connections).
- Cable slots: After connecting the fibers at the cards they have to be guided through the cable slots. In combination with adjacent space and the bending radius (25 mm) given by the guiding plastic parts, this will avoid accidental crimping and squeezing of the optical fiber.

After connecting the cables at the plug-in modules, they have to be run through the cable slots. Then the cable has to be bent sideward. In order to avoid cable squeezing, the cables are bent over plastic parts. Distribute the cables in the cable ducts symmetrically. Therefore, usage of the left or right side of the bay has to be checked in any case.

The cables are handled sideward to the cable outlets of the shelf. Over length (slack) must be stored in the cable compartment.

The minimum bending radius of the optical cables is 25 mm. The cable slots directly below the plug-in module have to be used.

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Fig. 182 Shelf Cable Duct (example)

Fig. 183 Edge protection (example)

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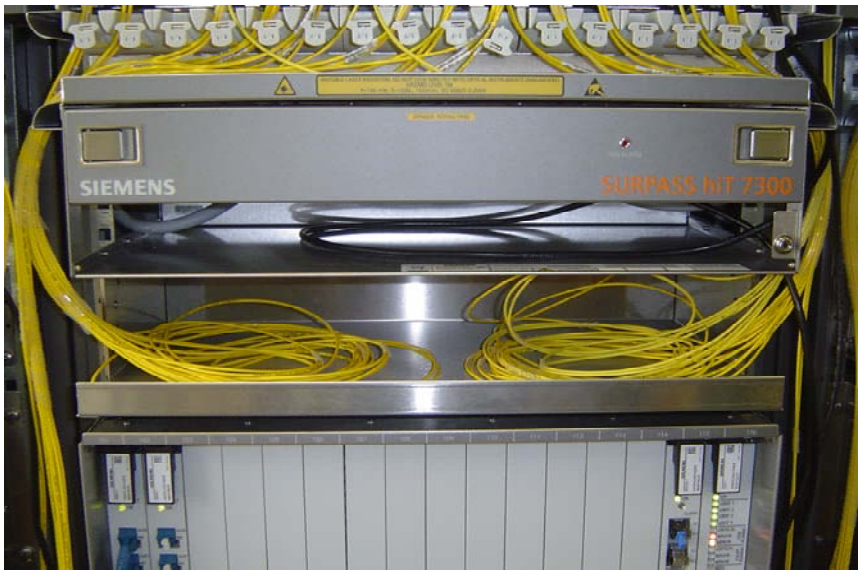

Fig. 184 Fiber Tray (example).

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6 Exercise

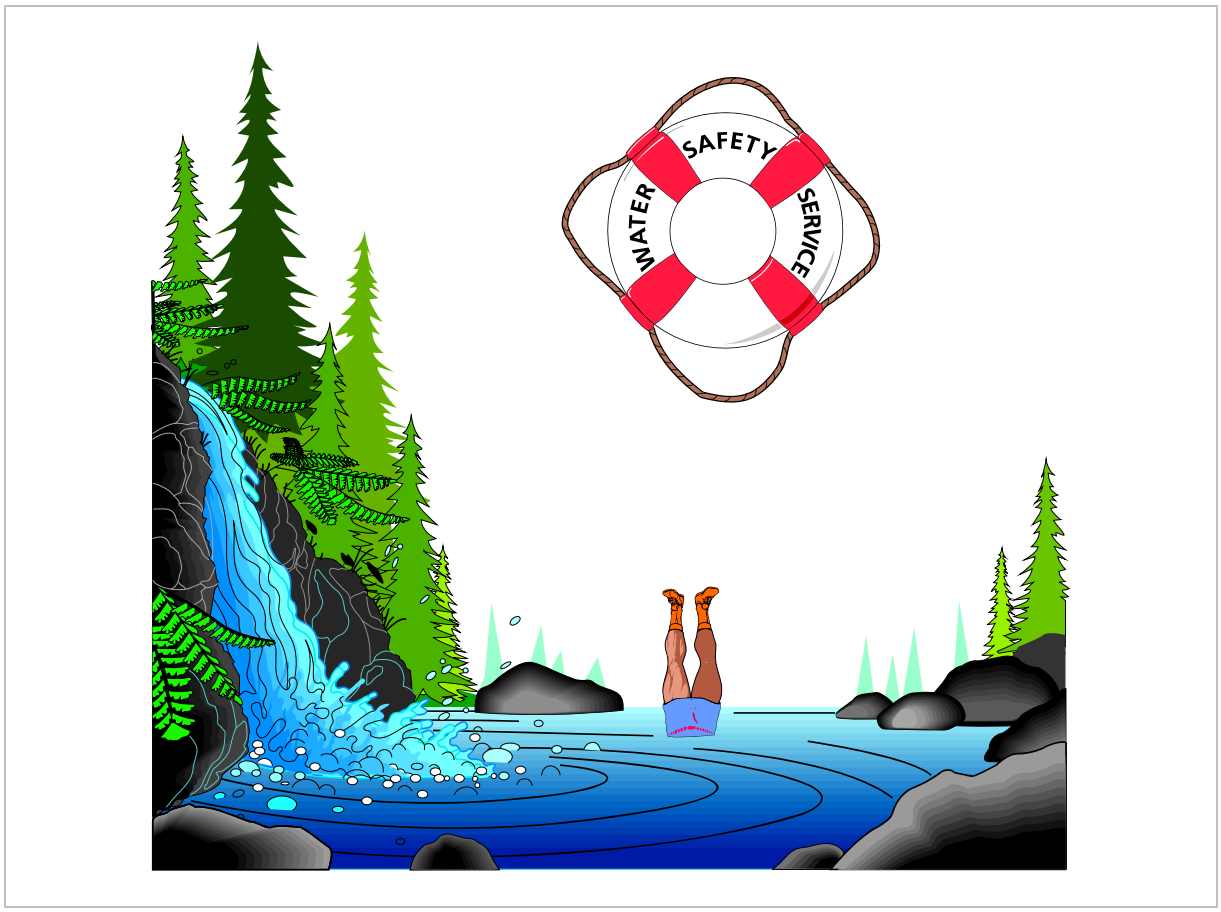

Fig. 185

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Exercise 1

Title:	Hardware and Functionality
Objectives:	Demonstrate that you know the main functions of the hardware of SURPASS hiT7300
Pre-requisite:	Pre-read chapter "Hardware and Functionality; Physical access to the equipments.

Task 1

Please form four teams. Ask your instructor for the name of your team (e.g. **student01**) and write it down in the field below:

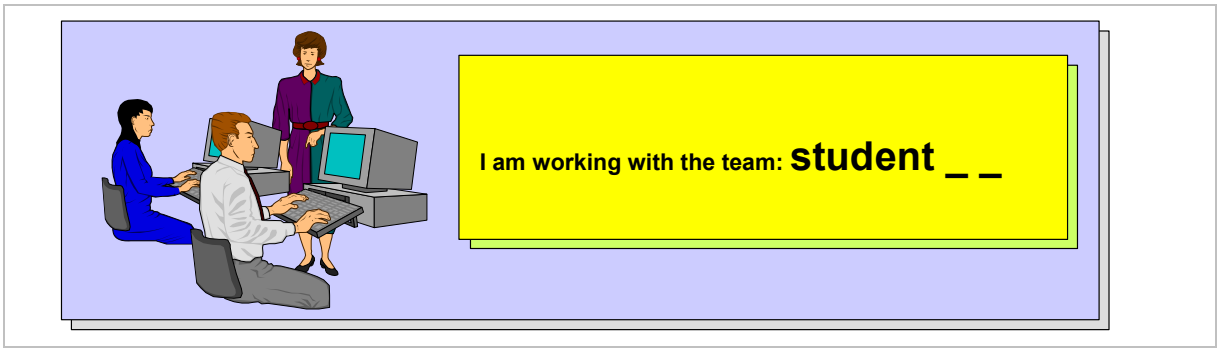

Fig. 186 Login information

Go to the LAB and dependent on the team number, you are responsible for the following NE:

Case of LAB1:

Group Name	NE Name	Row/Rack
Student01	Dresden	06 / 002
Student02	Hannover	06 / 007
Student03	Berlin	06 / 012
Student04	Jena	06 / 022
Student05	Weimar & Muenster	06 / 017

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Case of LAB2:

Group Name	NE Name	Row/Rack
Student01	Goslar	07 / 502 & 07 / 507
Student02	Olpe	07 / 507
Student03	Unna	07 / 512
Student04	Rastatt	07 / 517
Student05	Kamenz	07 / 522

Each team shall verify and write down in the table below the name of cards and the slot number where this card is inserted to for the NE assigned.

NE Name: _____					
Shelf 1		Shelf 2		Shelf 3	
Slot	Card	Slot	Card	Slot	Card
001		001		001	
002		002		002	
003		003		003	
004		004		004	
005		005		005	
006		006		006	
007		007		007	
008		008		008	
009		009		009	
010		010		010	
011		011		011	
012		012		012	
013		013		013	
014		014		014	
015		015		015	
016		016		016	

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Task 2

Using the information from the previous task (card types available in the NE assigned to your team), try to find out which hiT7300 NE type it is.

In the table below marked the correct NE type of the NE assigned to your team.

NE Type	Which NE type is assigned to my team?
OLR	☐
ONN-T	☐
ONN-I	☐
ONN-R	☐
ONN-S	☐
ONN-X	☐
SON	☐

TIP
Discuss in class the obtained results.

Task 3

In order to understand the optical signal flow each team shall write down the optical cable numbers of the NE in the appropriate fields of the cabling plan attached to this exercise.

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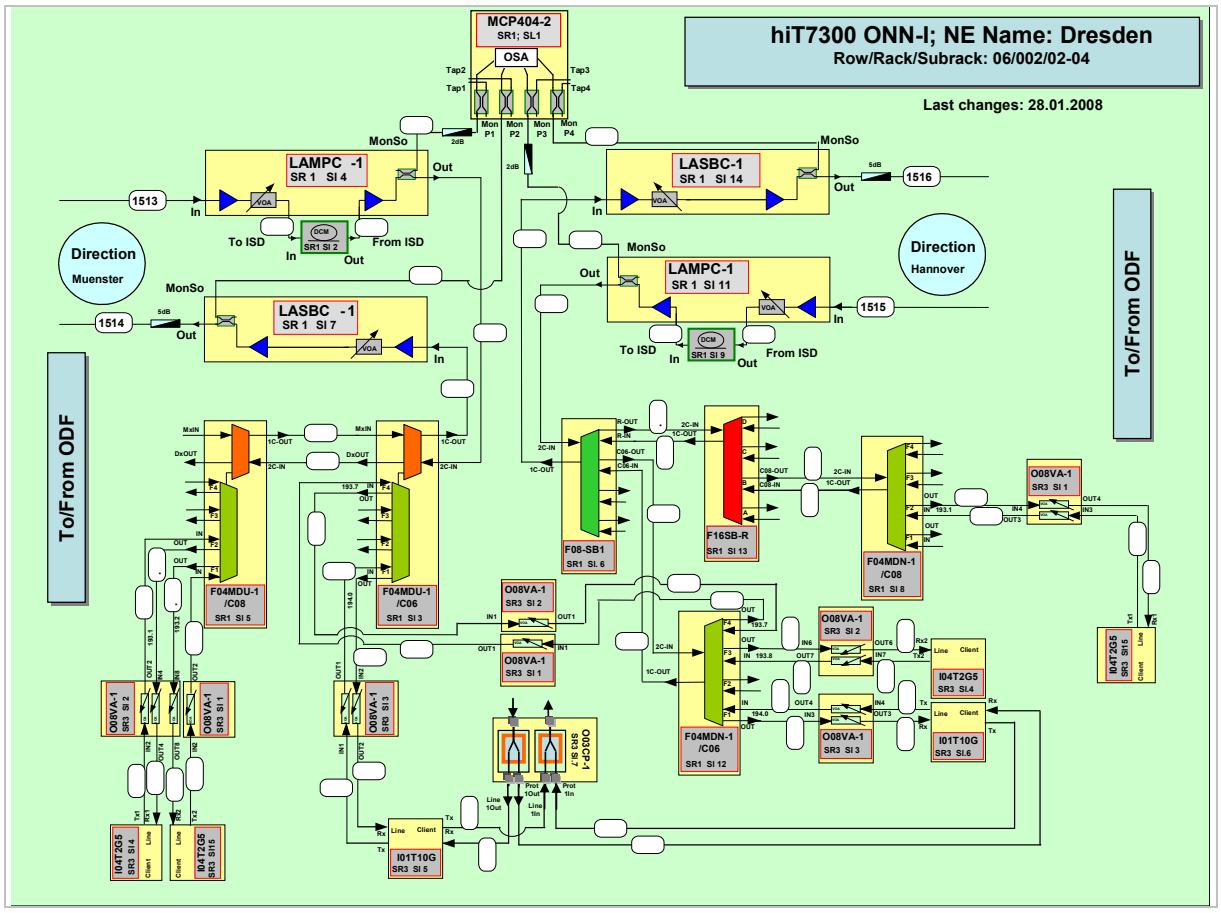

Fig. 187 NE Dresden SR1&SR3

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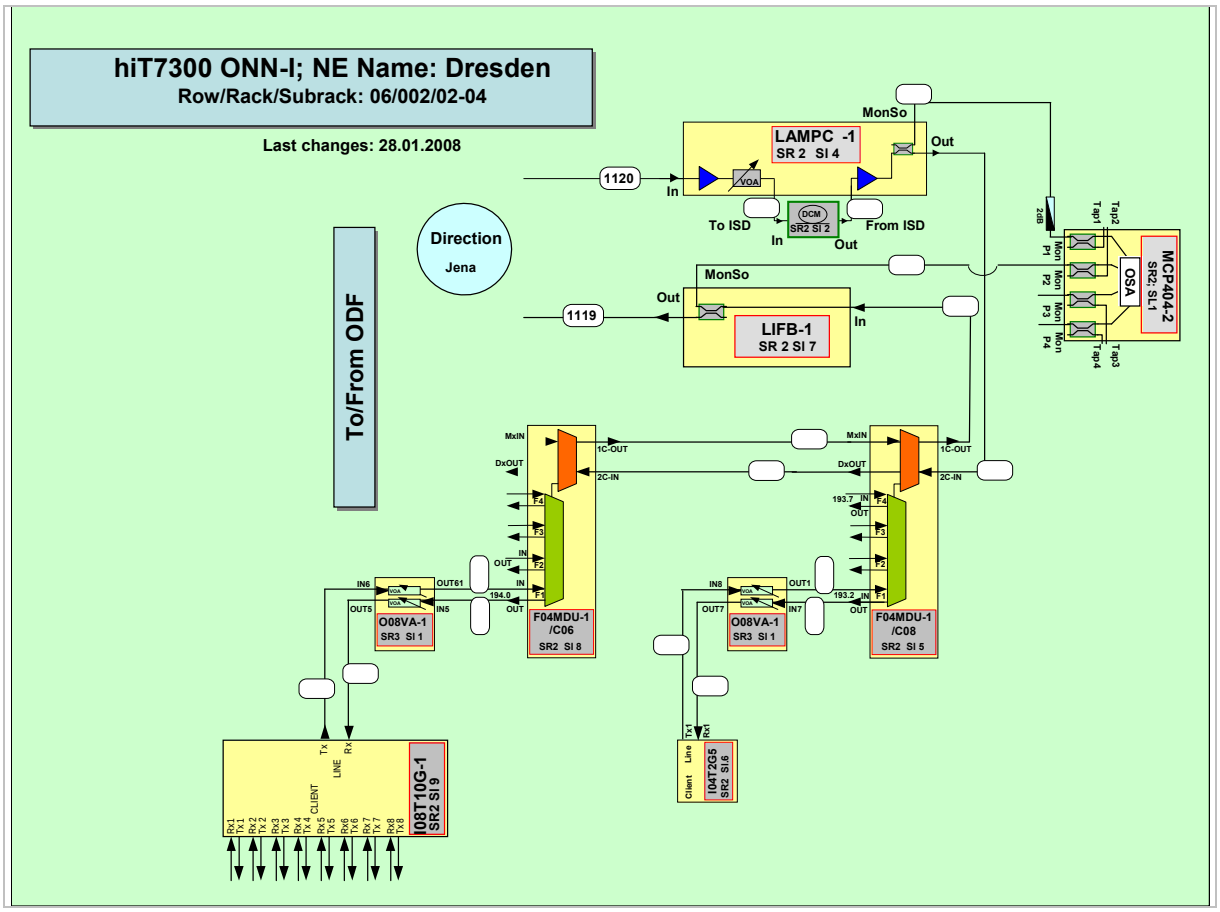

Fig. 188 NE Dresden SR2

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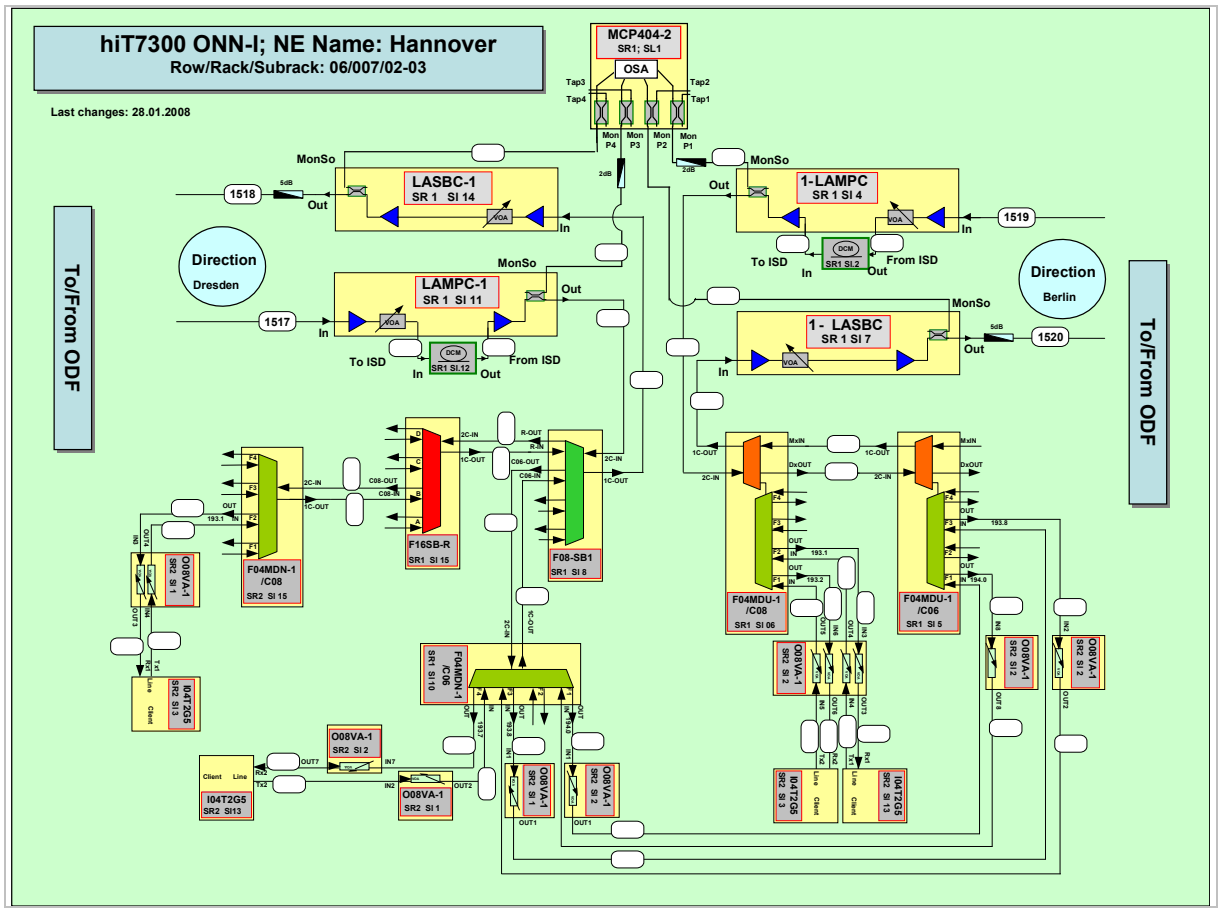

Fig. 189 Hannover SR1&2

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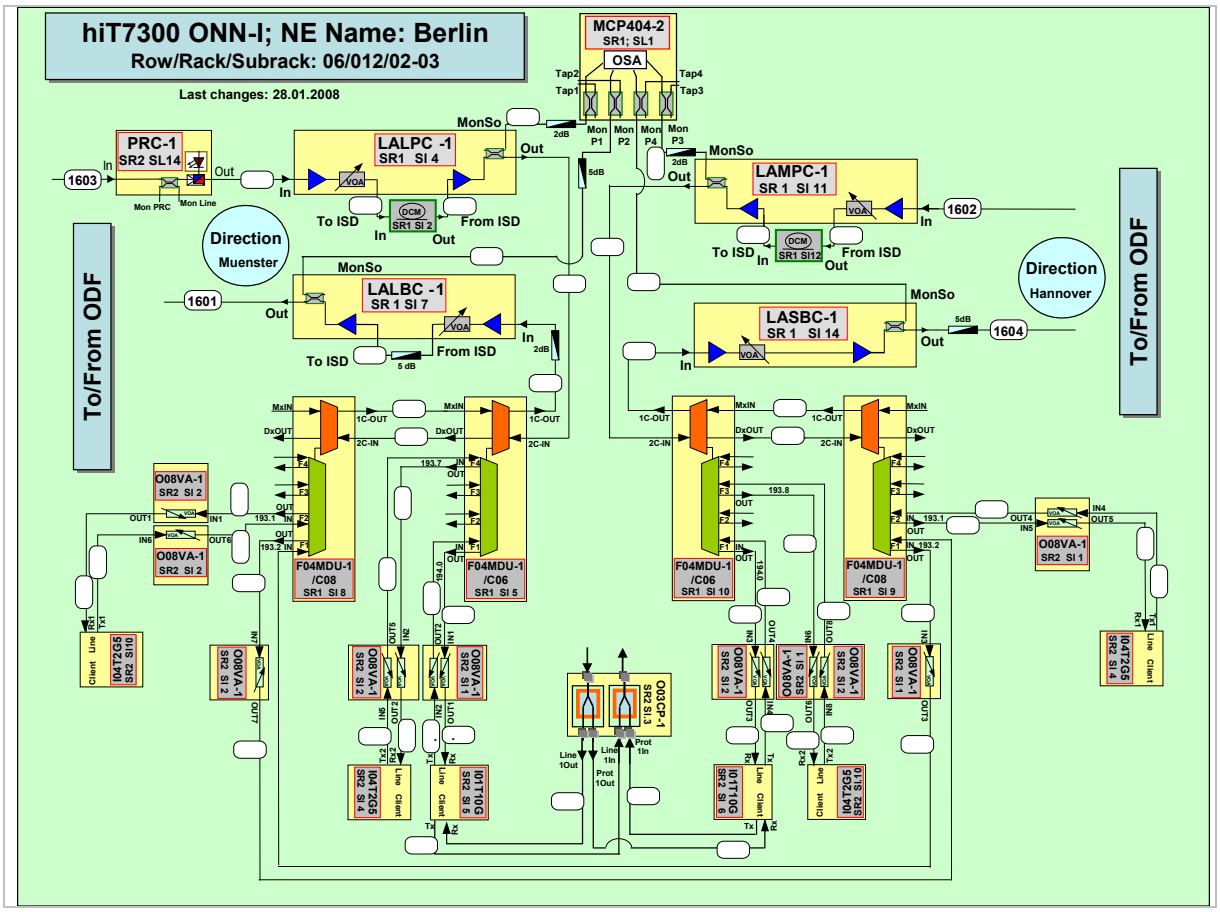

Fig. 190 NE Berlin SR1&2

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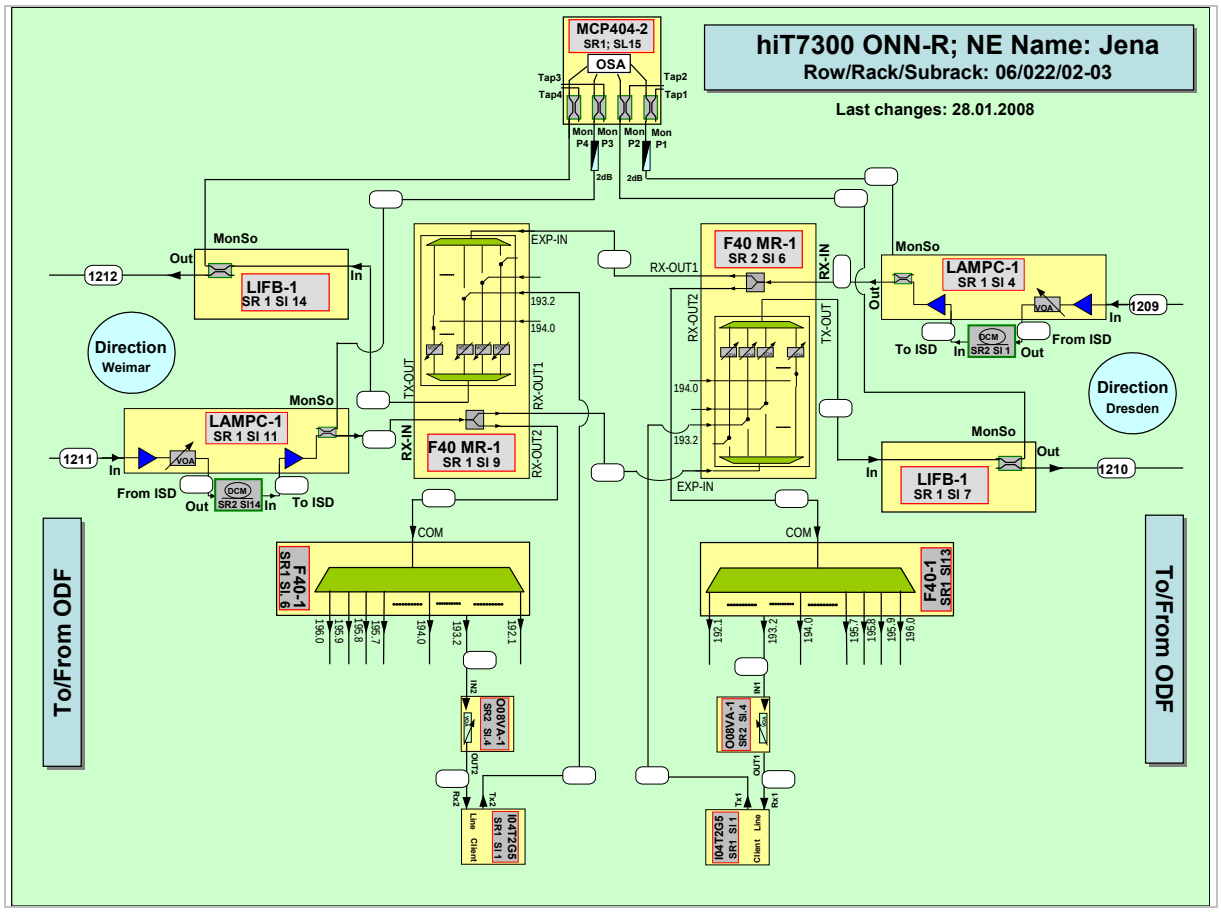

Fig. 191 NE Jena SR1&2

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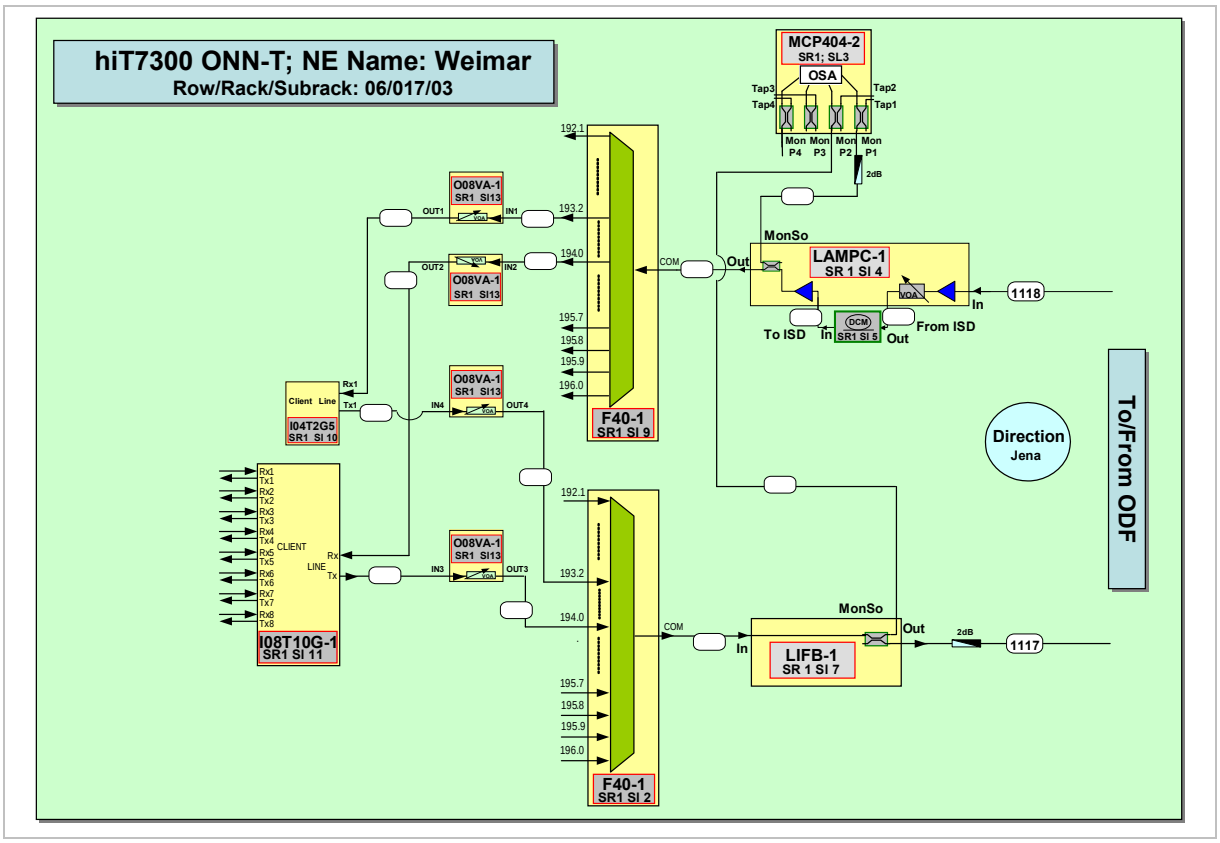

Fig. 192 NE Weimar SR1

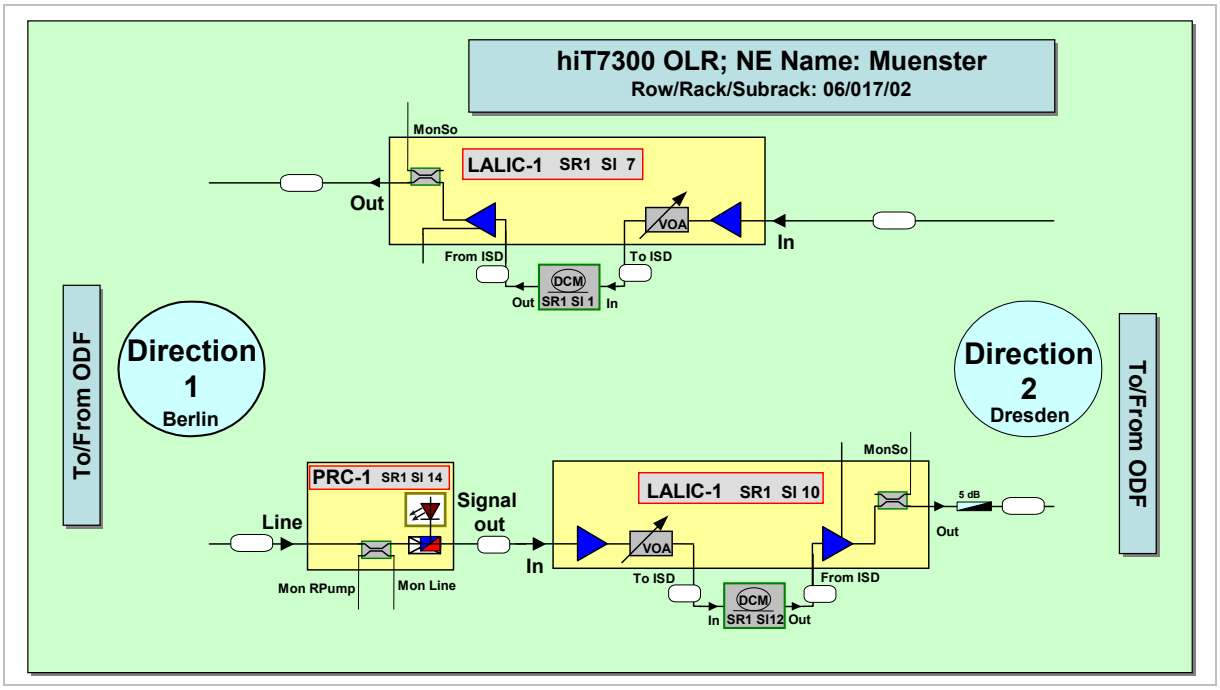

Fig. 193 NE Muenster SR1

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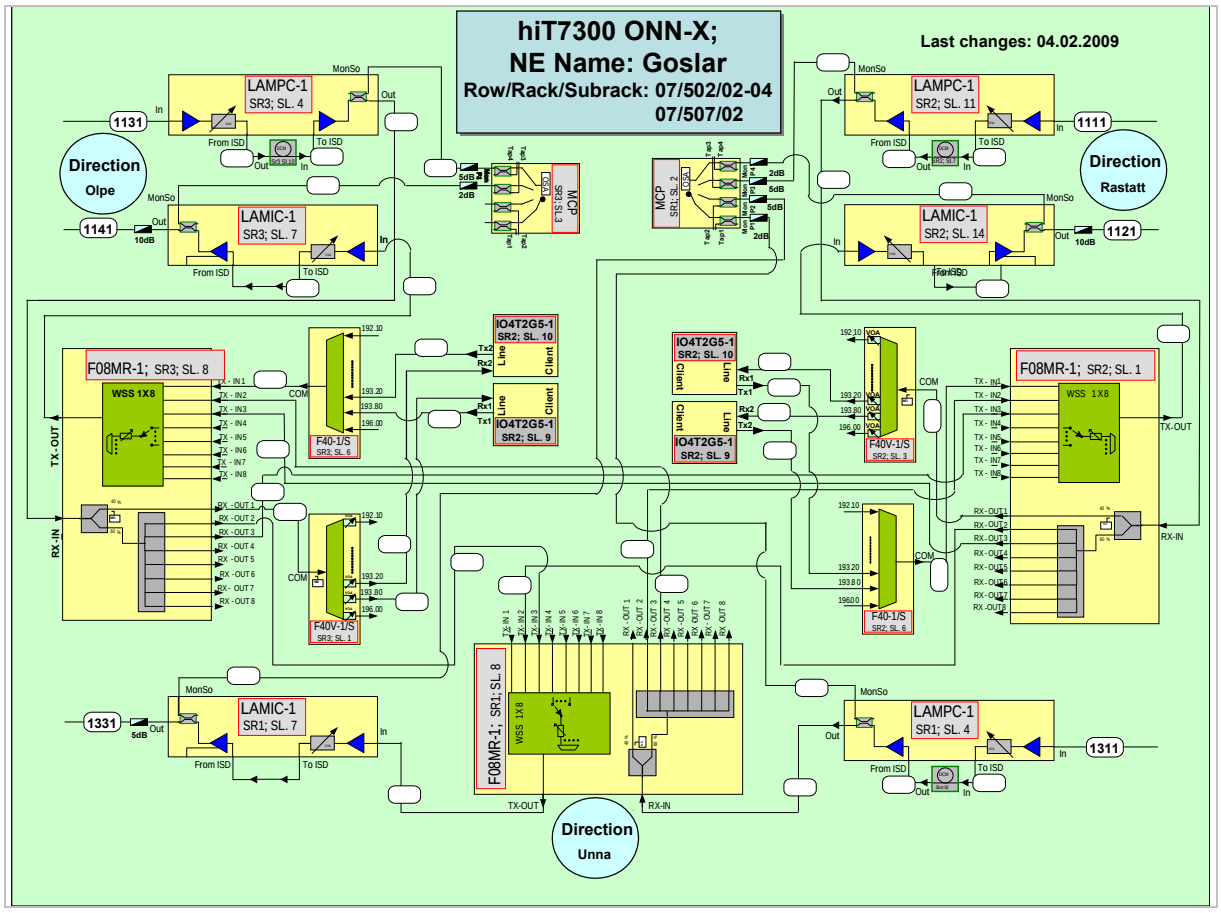

Fig. 194 Goslar SR1, 2&3

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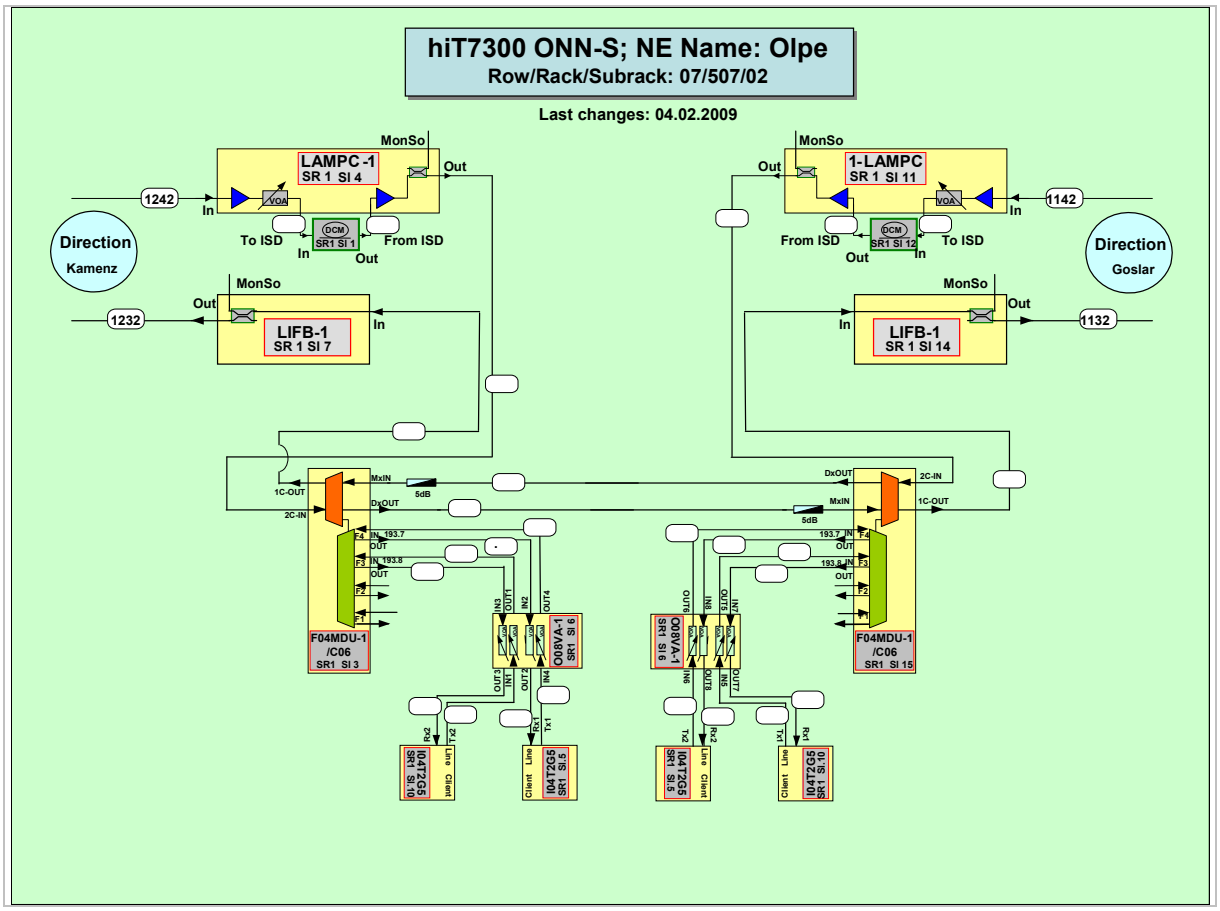

Fig. 195 Olpe SR1

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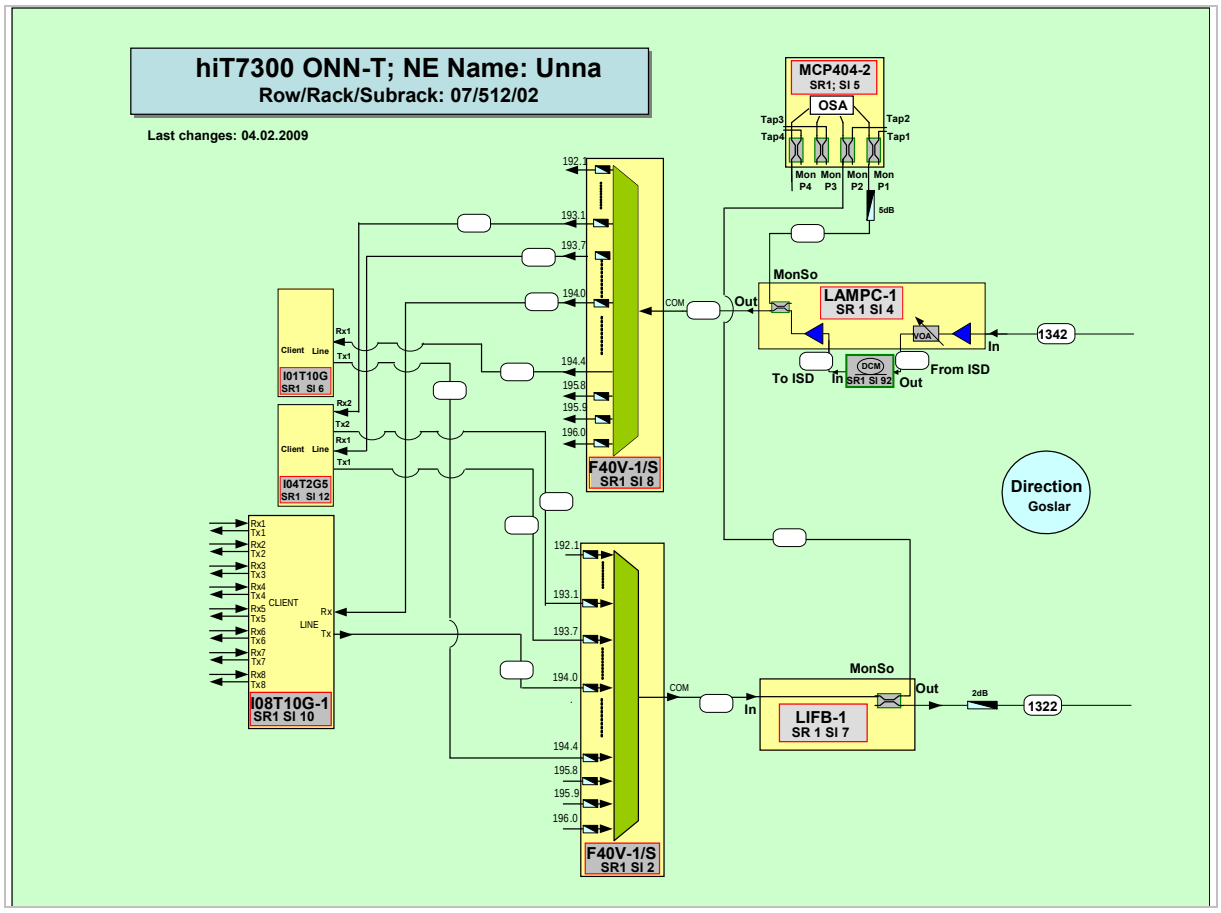

Fig. 196 Unna SR1

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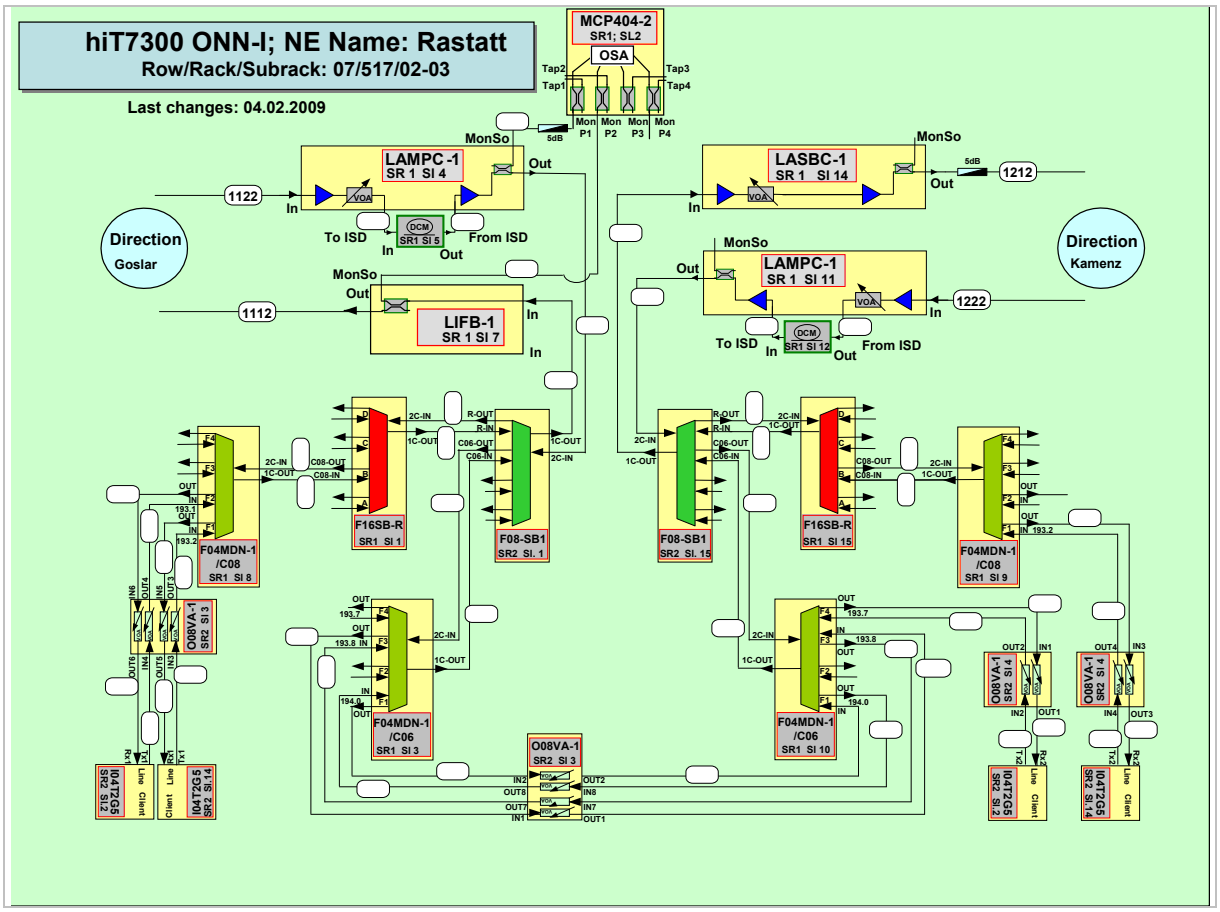

Fig. 197 Rastatt SR1&2

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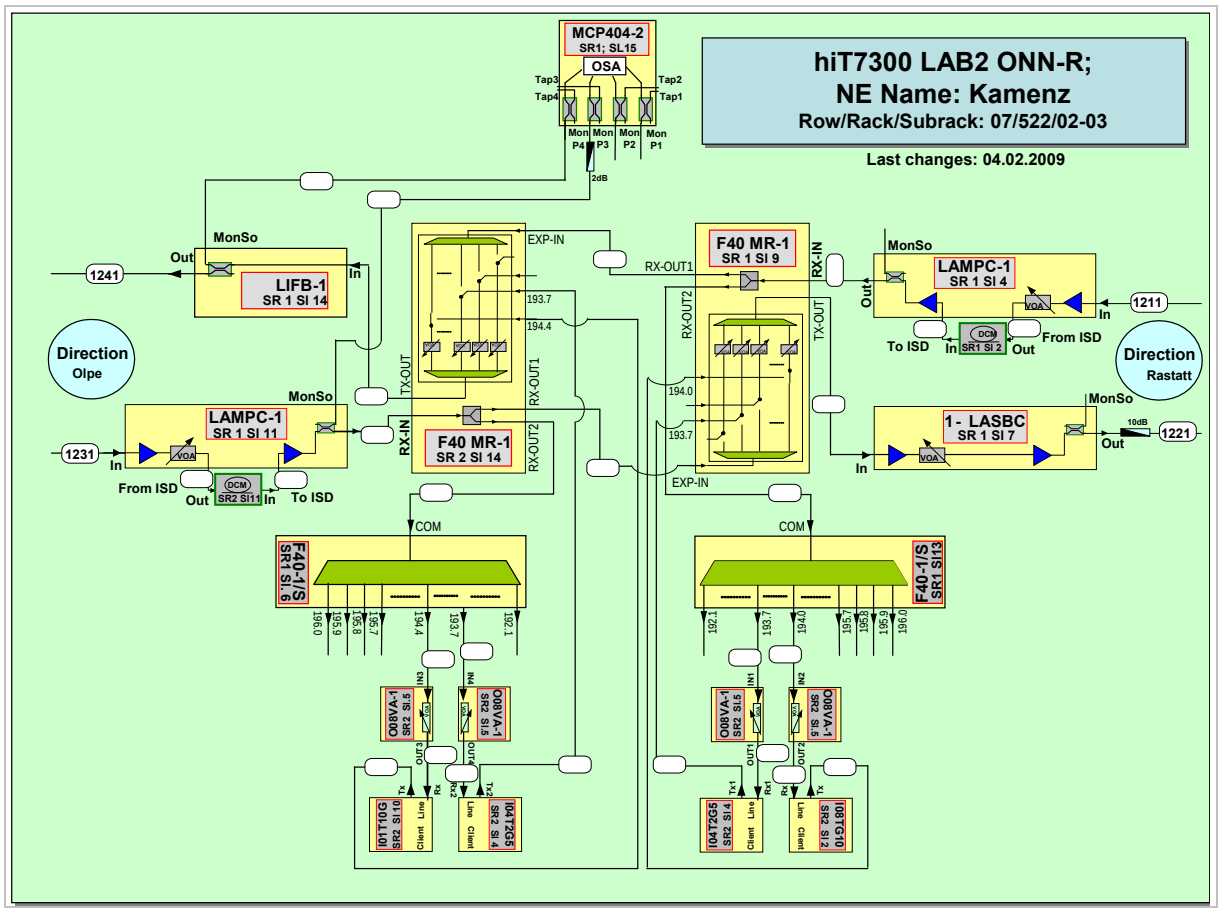

Fig. 198 Kamenz SR1&2

TIP

Discuss in class the obtained results.

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Fig. 199

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